VERMONT AGENCY OF NATURAL RESOURCES
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

DRAFT Water Quality Certification
(33 U.S.C. §1341)

In the matter of: Bellows Falls Hydroelectric Project
Great River Hydro LLC.
69 Milk Street; Suite 306
Westborough, MA 01581

APPLICATION FOR BELLOWS FALLS HYDROELECTRIC PROJECT

Section 401 of the federal Clean Water Act requires that any applicant for a Federal license or permit to conduct any activity including, but not limited to, the construction or operation of facilities, which may result in any discharge into the navigable waters, shall provide the licensing or permitting agency a certification from the State in which the discharge originates that any such discharge will comply with other substantive provisions of the Clean Water Act. 33 U.S.C. § 1341(a)(1). The certifying State may set forth any effluent limitations and other limitations, and monitoring requirements necessary to assure that any applicant for a federal license or permit will comply with the Clean Water Act and with any other appropriate requirement of State law. 33 U.S.C. § 1341(d). In Vermont, the Agency of Natural Resources is the certifying agency of the State for purposes of Section 401 of the Clean Water Act. 10 V.S.A. § 1004. The Secretary of Natural Resources has delegated the authority to make certification determinations to the Department of Environmental Conservation (Department). The Connecticut River is a boundary water with the state of New Hampshire and the Application is being reviewed by the New Hampshire Department of Environmental Services for consistency with the New Hampshire Water Quality Standards.

The Department has reviewed a water quality certification application dated April 18, 2024, and filed by Great River Hydro (the Applicant or GRH) for the Bellow Falls Hydroelectric Project (the Project). The supporting documentation for the certification application includes the Applicant's Federal Energy Regulatory Commission (FERC) final license application (FERC No. 1892) dated December 7, 2020, and the Applicant's amended final license application dated June 7, 2023, the settlement agreement on fish passage filed with FERC on August 2, 2022 and other supporting documents filed by the Applicant in support of the application. The record for this decision includes these supporting documents, including the Applicant's responses to the February 18, 2022, September 2, 2022, and October 4, 2022, FERC Additional Information Requests (AIR); and many other documents related to the Project and its relicensing filed through December 13, 2024. An Environmental Impact Statement for the Project to be conducted by FERC has yet to be completed.

The current application is subject to review under the Vermont Water Quality Standards promulgated by the Agency of Natural Resources and effective November 15, 2022 (Environmental Protection Rule, Chapter 29A) (VWQS or Standards). (Standards, Section 29A-101 Applicability).

The Department will hold a hearing on February 12, 2025, at 5:30 PM to receive oral comments. The Department will also accept written or voicemail comments through 4:30 PM on February 26, 2025. For additional information on the draft decision, application, and any pertinent updates can be found at the

Vermont Agency of Natural Resources Environmental Notice Bulletin Board (https://enb.vermont.gov/), by searching for the Project name.

The Department, based on the application and record before it, makes the following findings and conclusions.

I. Applicable Statues and Regulations

A. Applicable Provisions of the Vermont Water Quality Standards

1. The applicable 2022 Vermont Water Quality Standards (Standards) were adopted by the Secretary of the Agency of Natural Resources pursuant to 10 V.S.A., Chapter 47, Water Pollution Control. Section 1252 of Chapter 47 provides for the classification of designated uses as either Class A(1), A(2), B(1) or B(2) and authorizes the adoption of standards of water quality to achieve the purpose of classification.

2. All waters of the State shall be managed to support their designated and existing uses. (Standards, Section 29A-104(b)).

3. The designated uses of waters of the State are: aquatic biota and wildlife that may utilize or are present in the waters; aquatic habitat to support aquatic biota, wildlife, or plant life; the use of waters for swimming and other primary contact recreation; the use of waters for boating and related recreational uses; the use of waters for fishing and related recreational uses; the use of waters for the enjoyment of aesthetic conditions; the use of the water for public water source; and the use of water for irrigation of crops and other agricultural uses. (Standards, Section 29A-104(d)).

4. The affected reaches of the Connecticut River have been classified as Class B(2) for all uses.

5. The Antidegradation Policy in the Standards requires that "[a]ll waters shall be managed in accordance with these [Standards] to protect, maintain, and improve water quality." (Standards, Section 29A-105).

6. The Connecticut River is designated as cold water fish habitat. (Standards, Section 29A-308).

7. In waters designated as cold water fish habitat and the Secretary determines are salmonid spawning or nursery areas important to the establishment or maintenance of the fishery resource, the dissolved oxygen (D.O.) standard is not less than 7 mg/L and 75 percent saturation at all times, nor less than 95 percent saturation during late egg maturation and larval development of salmonids. In all other waters designated as a cold-water fish habitat, the standard is not less than 6 mg/L and 70 percent saturation at all times. (Standards, Section 29A-302(5)(A)).

8. The general temperature standard for all waters is "[c]hange or rate of change in temperature, either upward or downward, shall be controlled to ensure full support of aquatic biota, wildlife, and aquatic habitat uses." (Standards, Section 29A-302(1)(A)).

9. In waters designated as cold water fish habitat and classified as Class B(2) for the fishing designated use, the total increase from ambient temperature due to all discharges and activities

shall not exceed 1.0°F. (Standards, Section 29A-302(1)(B)(iii)).

10. The turbidity standard as an annual average under dry weather base-flow conditions is 10 NTU for cold water fish habitat. (Standards, Section 29A-302(4)(A)).

11. The general criteria applicable to all waters include criteria that shall be achieved regardless of their classification including "Sludge deposits or solid refuse. None." (Standards, Section 29A-303(1)).

12. The management objectives for waters classified as Class B(2) for aquatic biota and wildlife are "[w]aters shall be managed to achieve and maintain good biological integrity" (Standards, Section 29A-306(a)(3)(A)). The Class B(2) criteria for aquatic biota and wildlife use require "Change from the natural condition for aquatic macroinvertebrate and fish assemblages not exceeding moderate changes in the relative proportions of taxonomic, functional, tolerant, and intolerant aquatic organisms." (Standards, Section 29A-306(a)(3)(B)).

13. The management objectives for waters classified as Class B(2) for aquatic habitat are "[w]aters shall be managed to achieve and maintain high quality aquatic habitat. The physical habitat structure, stream processes, and flow characteristics of rivers and streams and physical character and water level of lakes and ponds necessary to fully support all life-cycle functions of aquatic biota and wildlife, including overwintering and reproductive requirements, are maintained and protected" (Standards, Section 29A-306(b)(3)(A)). The Class B(2) criteria for aquatic habitat use in rivers and streams are "[c]hanges to flow characteristics, physical habitat structure, and stream processes limited to moderate differences from the natural condition and consistent with the full support of high quality aquatic habitat (Standards, Section 29A-306(b)(3)(B)(i)). Additionally, "[w]aters shall comply with the Hydrology Criteria in Section 29A-304" of the Standards (Standards, Section 29A-306(b)(3)(B)(iii)).

14. The hydrology policy in the Standards requires that "[t]he proper management of water resources now and for the future requires careful consideration of the interruption of the natural flow regime and the fluctuation of water levels resulting from the construction of new, and the operation of existing, dams, diversions, and other control structures" (Standards, Section 29A-103(f)(1)).

15. To effectively implement the hydrology policy, hydrology criteria shall be achieved and maintained, where applicable (Standards, § 29A-304(a)). The hydrology criteria require for waters classified as Class B(2) for aquatic habitat that "[a]ny change from the natural flow regime shall provide for maintenance of flow characteristics that ensure the full support of uses and comply with the applicable water quality criteria." Further, the Standards establish "the preferred method for ensuring compliance with this subsection is a site-specific flow study. In the absence of a site-specific study, the Secretary may establish hydrologic standards and impose additional hydrologic constraints, consistent with any applicable Agency of Natural Resources rule or procedure, to ensure compliance with the requirements of this subsection." (Standards, Section 29A-304(b)(3)).

16. The water level fluctuation criteria for lakes, ponds, reservoirs, riverine impoundments, and any other waters classified as B(2) for aquatic habitat or boating establish that "waters may exhibit artificial variations in water level when subject to water level management, but only

to the extent that such variations ensure full support of uses" (Standards, Section 29A-304(d)(2)).

17. The management objectives for waters classified as Class B(2) for aesthetics are "[w]aters shall be managed to achieve and maintain good aesthetic quality" (Standards, Section 29A-306(c)(3)(A)). The Class B(2) criteria for aesthetics in rivers and streams are "[w]ater character, flows, water level, bed and channel characteristics, and flowing and falling water of good aesthetic value." (Standards, Section 29A-306(c)(3)(B)(i)).

18. The management objectives for waters classified as Class B(2) for boating are "[w]aters shall be managed to achieve and maintain a level of water quality compatible with good quality boating (Standards, Section 29A-306(d)(3)(A)). The Class B(2) criteria for boating use is "[w]aters shall comply with the Hydrology Criteria in Section 29A-304 of these rules." (Standards, Section 29A-306(d)(3)(B)).

19. The management objectives for waters classified as Class B(2) for swimming and other primary contact recreation are "[w]here sustained direct contact with the water occurs, waters shall be managed to achieve and maintain a level of water quality compatible with good quality swimming and other primary contact recreation with very little risk of illness or injury from conditions that are a result of human activities." (Standards, Section 29A-306(f)(3)(A)).

20. The management objectives for waters classified as Class B(2) for fishing are "[w]aters shall be managed to achieve and maintain a level of water quality compatible with good quality fishing. (Standards, Section 29A-306(e)(3)(A)). The criteria for fishing are "[m]easures of wild salmonid densities, biomass, and age composition indicative of good population levels" and compliance with the temperature criteria in Section 29A-302(B) of the Standards. (Standards, Sections 29A-306(e)(3)(B)(i) and 29A-306(e)(3)(B)(ii)).

II. Factual Findings

A. General Setting and Background

21. The Connecticut River is the longest river in New England flowing approximately 407 miles. The sources of the Connecticut River are the Connecticut lakes located in the town of Pittsford, New Hampshire just south of the border with Quebec, Canada. The river flows southerly creating the 255 miles long boarder of Vermont and New Hampshire, and continues to flow through Massachusetts and Connecticut to the Long Island Sound. The river drains an area of 11,250 square miles.

22. The Connecticut River has long been used for various economic purposes. The river was used for large log drives beginning around 1865 and continuing until the early 1920s. The Village of Bellows Falls was home to numerous lumber and paper mills along the river with the Bellows Fall Hydroelectric Project (Project) being used solely to power the mills.

23. The Connecticut River is heavily developed for the production of hydroelectric power. There are 12 FERC-licensed hydropower projects located on the mainstem of the Connecticut River. There are numerous other hydropower projects located on the tributaries to the Connecticut River, in addition to several other dams operated by the U.S. Army Corps of Engineers for the purposes of flood reduction.

24. The Bellows Falls Hydroelectric Project (FERC No. 1855) is an existing licensed project located on the Connecticut River at river mile 173.7, about one mile upstream of the Saxtons River confluence and three miles downstream of the Williams River confluence with the Connecticut River. The Project is located in Bellows Falls, Vermont in the towns of Rockingham, Vermont, and Walpole, New Hampshire. The Project impoundment extends upstream about 26 miles to Chase Island at Windsor, Vermont, about one mile below the Windsor Bridge. The Project utilizes a drainage area of 5,414 square miles.

25. The original license for the Project was issued jointly to New England Power Company, Bellows Falls Hydro-Electric Corporations, and the Connecticut River Power Company on October 13, 1943. New England Power Company subsequently purchased the physical properties and franchise of Bellows Falls Hydro-Electric Corporation and became the licensee as authorized by Federal Energy Regulatory Commission (FERC) on July 9, 1948.

26. The original license expired on June 30, 1970. The Project continued to operate on an annual basis until the license was renewed on August 3, 1979. During the license renewal process, FERC approved a settlement agreement which included fish passage facilities for American shad and Atlantic salmon at the Project. It also included fish passage facilities for the Wilder (FERC No. 1892) and Vernon (FERC No. 1904) hydroelectric projects on October 5, 1978. Parties to the settlement included the commonwealth of Massachusetts, and the states of Connecticut, New Hampshire, and Vermont, the U.S. Fish and Wildlife Service, and four non-governmental organizations which were the Environmental Defense Fund, the Massachusetts Public Interest Research Group, For Land's Sake, and Trout Unlimited.

27. This agreement required staged design, construction and operations of fish passage facilities at the three Projects. The Bellows Falls upstream fishway was subsequently completed and commenced operations in 1984. In July 1990, the licensee entered into a Memorandum of Agreement with the Connecticut River Atlantic Commission for downstream passage, which began at the Bellows Falls Project in 1996.

28. In 1998, FERC approved transfer of the license from New England Power Company to USGen New England, Inc. Subsequently, in 2005 the license was transferred to TransCanada Hydro Northeast Inc. Lastly, in 2017 the licensee changed its name from TransCanada Hydro Northeast LLC. to Great River Hydro, LLC. There was no legal identity change with this change in name.

B. Project and Civil Works

29. The dam is a 643-foot long concrete gravity structure extending across the river between Rockingham, Vermont and Walpole, New Hampshire. The dam has a maximum height of approximately 30 feet and is divided by concrete piers into five bays. Two bays contain steel roller-type gates that are 18 feet high by 115 feet in length. The three other bays contain stanchion flashboards. Two of the bays measure 13 feet in height and 121 feet long, with the third being 13 feet high and 100 feet long.

30. A steel bridge runs the length of the dam for access and operations of the flashboard stanchion bays. A 25-ton gantry crane sits atop the bridge.

31. Flow of the Connecticut River is conveyed to the powerhouse through a 1,700-foot-long

power canal, which includes a concrete walled powerhouse forebay at the downstream end. The canal is about 29 feet deep and is lined with stone stabilized by a grid of concrete beams and walls at grade. It is approximately 100 feet wide at the upstream end, gradually narrowing to a width of 36 feet near the powerhouse forebay area.

32. The powerhouse superstructure is 186 feet by 106 feet and 52 feet high and constructed of steel frame and brick. The substructure is constructed of reinforced concrete excavated into bedrock. The powerhouse contains electric equipment, a switchboard used for local station operations during emergency conditions, a machine shop, excitation equipment, emergency generator, overhead crane, battery room as well as offices and storage rooms.

33. The powerhouse contains 3 generating units. The units are vertical Francis type turbines each with a rating of 13.6 MW at 57 feet of head. The minimum and maximum hydraulic capacity for the units is 700 cubic feet per second (cfs) to 3,670 cfs. The maximum nameplate hydraulic capacity at the Project is 11,010 cfs.[1] However, based on operations data the maximum discharge through the units is 11,400 cfs. The Project currently has a 40.8 MW authorized generating capacity.

34. The concrete gravity intake for the units is built within powerhouse structure with two water passages for each of the three units. The water enters directly from the forebay area of the canal into the wheel or scroll cases. The intakes have two head gates that can be used in any one of the three units. One set of head gates, consisting of two gates measuring 25 feet high by 18.5 feet wide, is shared by all three units.

35. The draft tubes have a maximum dimension of 20 feet high by 31 feet wide and discharge into the 900-feet long tailrace that is partly excavated into riverbank and bed. There are no draft tube gates. Both the draft tubes and scroll cases are formed in the concrete of the powerhouse substructure, and poured on bedrock.

36. The intakes for the units have trashracks with 4-inch clear spacing and are equipped with a hydraulic rake to pull river debris away from the intake area of the units. The rake is manually operated and is driven to the trashracks in front of each unit on a set of tracks that are located on top of the forebay intake structure. Removed debris is conveyed into a trailer for removal. A 12-foot wide by 10-foot high ice sluice/skimmer gate is located on the east side of the forebay which can also be used to move debris and ice from the forebay area to the downstream.

37. Project electrical facilities include the generators, 6.6-kilovolt, generator leads that extend approximately 80 feet from the powerhouse to an outdoor switchgear house located in a substation west of the powerhouse, switchgear, bus work, and two step-up transformers located in the substation. The two switchyards and the tie lines from the step-up transformer are located within the Project boundary, but are not part of the Project facilities and are owned and operated by the regional transmission company, New England Power Company.

[1] The maximum nameplate hydraulic capacity is based on design specifications of the turbine (or nameplate rating) and is the sum of the hydraulic capacities of all units in the powerhouse.

Fish Passage Infrastructure

38. The upstream fish ladder system is located at the powerhouse. The fish ladder is a reinforced concrete structure that is 920 feet long consisting of conventional vertical slotted weirs with electrical, mechanical and pneumatic equipment that is designed to provide passage for Atlantic salmon.

39. Upstream migrating fish are initially attracted to the tailrace channel by flow from the turbines. Once in the tailrace area, fish are attracted to the main entrance weir at the east end of the powerhouse. To maintain the required flow within the ladder the upper three weirs contain slide gates which open and close depending on the surface water elevation of the forebay. Additional attraction flow to the fish ladder is provided from a skimmer gate / sluiceway located in the forebay. Water from this channel enters two diffuser openings at the entrance to the ladder.

40. The entrance to the fish ladder is eight-feet wide. It contains a series of 67 slots and cascading pools with each succeeding weir spaced eight feet apart and 12 inches higher than the previous. After passing through 34 pools, fish enter a level turning section and pass through another 10 pools to the counting and trap area of the ladder. At this area of the ladder, fish are guided by flow and a crowder screen to travel through a 3-foot-wide flume and pass by an underwater viewing window where they can be observed and counted.

41. From the counting and trap area of the ladder, fish continue to swim through an additional 22 pools to the eight-foot-wide exit channel of the ladder into the forebay and power canal. The last pool of the ladder which creates the exit includes a motor driven head gate, widely spaced trashracks, and slots for wooden stop logs. Additionally, the last three weirs contain adjustable weir gates that can be lowered to provide a nearly constant 25 cfs to the fish ladder when the surface water elevation of the forebay is within the operating range.

42. The fish ladder visitor center, operated by the Grafton Nature Museum, is located adjacent to the upper two pools and exit channel. In the basement of the building there is a public viewing gallery with two underwater windows. The Connecticut River Atlantic Salmon Commission provides an annual fish passage notification schedule which sets the dates for upstream passage for all of the dams on the river. Typically, the upstream fish passage operates once an Atltantic salmon is observed at Vernon through July 15 and in the fall from September 15 through November 15 when Atlantic salmon are present. However, since 2013 when the Atlantic salmon restoration program was suspended by the US Fish and Wildlife Service, the fish ladder has been operated for Sea lamprey. The opening dates for the ladder are contingent on when Sea lamprey are present at the Vernon dam.

43. Downstream fish passage has historically been provided by the forebay sluiceway/skimmer gate with fish being guided to the gate by a solid, partial depth diversion boom across the canal. A small diversion gate located on the east side of the powerhouse was opened to direct fish that may get under the diversion boom to the sluiceway. The gate is motorized and operated locally as needed to pass river debris and ice. Downstream fish passage at Bellows Falls has not been provided since 2016.

C. River Hydrology

44. The Connecticut River is extensively developed for hydropower and flow at the Bellows Falls

Project is highly regulated. Upstream of Bellows Falls is the Wilder Project which is currently operated in a peaking mode. Above Wilder is Dodge Falls Dam, a FERC regulated run-of-river[2] facility, and the Fifteen Mile Falls Project (FMF)[3] which is a FERC regulated peaking project comprised of McIndoes, Comerford, and Moore facilities.

45. Upstream of FMF, are Gilman (FERC No. 2392) and Cannan (FERC No. 7528) hydroelectric projects. Both projects operate in a run-of-river mode. Additionally, upstream of the Cannan Project are the First Connecticut Lake, Second Connecticut Lake and the Murphy Dam on Lake Francis. The dams on these waterbodies are managed to maintain lake level and augment downstream flow of the Connecticut River.

46. At the Bellows Falls Project, approximately 3,375 of the 5,414 square miles watershed area utilized is regulated by Wilder and FMF with the remaining 2,039 square miles of the intermediate drainage being largely unregulated natural flow.

47. As part of the relicensing of the Wilder Hydroelectric Project, the Applicant, GRH, has proposed to operate the project predominately with outflow approximately equal to inflow by maintaining a relatively stable impoundment level at the dam while maintaining capability to be flexible and responsive to various energy issues and services that are managed by the New England Independent System Operator.

48. The peaking operations of FMF Project will continue to have an effect on the Wilder facility. Project operations at FMF take approximately eight hours to affect the Wilder dam. GRH operates its generation facilities in conjunction with each other, which includes FMF. Under current peaking operations, the travel time of releases from the Wilder Project to Bellows Falls is approximately eight hours. The degree of storage at the FMF Project provides for flow regulation on larger timeframes, up to seasonally.

49. The Wilder Project, located 43 miles upstream of the Bellows Falls Project and the Vernon Project, located 32 miles downstream, are also owned by the Applicant and are concurrently undergoing relicensing. These three projects are currently operated together to enhance power production which results in substantial flow regulation, primarily on an intraday and interday basis. Downstream of Vernon are the Turners Falls Project, the Northfield Mountain Pumped-Storage Project, and the Holyoke Project located in Massachusetts.

50. There are no known water withdrawals within the impoundment of the Bellows Falls Hydroelectric Project.

51. However, it should be noted that not all water withdrawals may be known. As of 2023, Vermont enacted a water withdrawal registration program. The program requires an individual or applicant withdrawing more than 10,000 gallons or more of surface water within a 24-hour

[2] Dodge Falls FERC Number 8011 is a FERC exempt project that was licensed in 1984. A true run-of-river project is one which does not operate out of storage and therefore, does not artificially regulate streamflow below the project's tailrace. Outflow from the project is equal to inflow to the project's impoundment on an instantaneous basis. The flow regime below the project is essentially the river's natural regime, except in special circumstances, such as following the reinstallation of flashboards and project shutdowns. Under those circumstances, a change in storage contents is necessary, and outflow is reduced below inflow for a period.
[3] Fifteen Miles Falls FERC Number 2077 was relicensed in 2002. The Fifteen Miles Falls project consists of McIndoes, Comerford, and Moore dams.

period, or 150,000 gallons or more over a 30-day period to register with the state. It should also be noted that New Hampshire requires registration for individuals or companies withdrawing more than 20,000 gallons of water a day averaged over 7 days, or more than 60,000 gallons per day in a 30-day period. If an applicant withdraws less water than New Hampshire or Vermont registration requirements, then it is likely that these withdrawals would remain unknown.

52. There are numerous water gaging stations located on the Connecticut River, and its tributaries near their confluence with the Connecticut. The gaging stations located on the Connecticut River bordering Vermont include USGS gage No. 01129500 near North Stratford, USGS gage No. 01131500 near Dalton, USGS gage No. 01138500 at the Wells River, USGS gage No. 01144500 at West Lebanon, and USGS gage No. 0115450 at North Walpole. These gages have been in operation since 1990, with some beginning operations in 1988. There are additional gages in the Connecticut River Watershed that are either still in operation or have operated historically but are no longer collecting current data.

53. As noted above, the reach of the Connecticut River comprises the boundary between Vermont and New Hampshire and is highly regulated starting at the First Connecticut and Second Connecticut lakes continuing through to the boundary with the commonwealth of Massachusetts. Although the gages on the mainstem reflect regulated hydrology, there are a number of gages in the Connecticut River watershed that are not hydrologically regulated or altered. For this reason, with reasonable assumptions, estimates can be made to approximate the natural hydrologic condition of the Connecticut River system.

54. Table 1 below reflects the hydrologic condition of the Connecticut River in the vicinity of the Bellows Falls Project. The first column represents an estimate of the natural unregulated flows. The natural unregulated flows represent the average of flows from unregulated gages within the Connecticut River watershed upstream of Bellows Falls Project prorated to the facility. The list of gages where flow data was used, along with the drainage area, in square miles, and the period of record are provided in Table 2.

55. The second column of Table 1 is an estimate of the observed regulated flows above the Bellows Falls dam prorated to the dam. The flow data used for the calculation was from the Connecticut River gage located at West Lebanon, New Hampshire (USGS Gage No. 01144500) with a period of record from 1980-2023.

56. The last column in Table 1 is an estimate of regulated flows below the Bellows Falls dam. The data used to calculate these values were from the Connecticut River gage at North Walpole, New Hampshire (USGS Gage No. 1154500) with a period of record from 1980-2023.

Table 1. Estimated unregulated and regulated monthly median and 7Q10[4] flows of the Connecticut River at the Bellows Falls dam. Estimates vary depending on location of gages used for calculation. Data is presented in cubic feet per second per square mile (csm) and cubic feet per second (cfs).

Monthly Median and 7Q10	Estimated Unregulated Flows (csm/cfs)	Pro-rated Regulated Flows above Bellows Falls dam (csm/cfs)	Pro-rated Regulated Flows below Bellows Falls dam (csm/cfs)

[4] The 7Q10 is defined as a flow equal to the lowest mean flow for seven consecutive days that has a 10% chance of occurring in any given year.

January	0.91	4,943	1.27	6,881	1.28	6,904
February	0.8	4,303	1.17	6,346	1.18	6,362
March	1.36	7,334	1.83	9,902	1.97	10,637
April	3.91	21,140	3.74	20,228	3.99	21,569
May	2.39	12,494	2.3	12,454	2.27	12,262
June	1.08	5,858	1.3	7,053	1.28	6,934
July	0.59	3,173	0.85	4,614	0.8	4,343
August	0.45	2,421	0.69	3,755	0.63	3,413
September	0.44	2,358	0.62	3,371	0.56	3,009
October	0.76	4,117	0.99	5,381	0.96	5,171
November	1.32	7,138	1.49	8,071	1.49	8,081
December	1.18	6,401	1.5	8,131	1.53	8,278
7Q10	0.15	822	0.3	1,633	0.26	1,428

Table 2. USGS gages on unregulated streams used to estimate natural monthly median and 7Q10 flows that flow into the Connecticut River above the Bellows Fall Hydroelectric Project.

USGS Gage Number	USGS Gage Name	Drainage Area (square miles)	Period of Record
1127880	Big Brook near Pittsburg, NH	6.36	1964-1984
1129300	Halls Stream near East Hereford, Quebec	85	1963-1992
1129440	Mohawk River near Colebrook, NH	36.7	1987-2004
1130000	Upper Ammonoosuc River near Groveton, NH	232	August 1940 to November 1980. October 1982-September 2004. July 2009 to current year
1135500	Passumpsic River at Passumpsic, VT	436	1930-2018
1138000	Ammonoosuc River near Bath, NH	395	1936-1981
1139800	East Orange Branch at East Orange, VT	8.95	1959-2018
1139000	Wells River at Wells River, VT	98.4	1941-2018
1141800	Mink Brook near Etna, NH	4.6	1962–98
01153550	Williams River near Rockingham, VT	112	1987-2023

01152500	Sugar River at West Claremont, NH	269	1929-2023
01150900	Ottauquechee River near West Bridgewater, VT	23.4	1985-2023
01144000	White River at West Hartford, VT	690	1916-2023
01145000	Masccoma River at West Canaan, NH	80.5	1940-1978

57. The Applicant also developed an operations model as part of the relicensing process (study 5). This study allows for additional metrics to be estimated. The operations model uses an intensive HEC-RAS model with inputs from upstream facilities, operations, and water surface elevation data collected at various nodes within the impoundment and downstream of the facility and inflow estimates. The inflow estimates allow the Applicant to understand what inflow equals outflow (IEO) is from the Project and develop metrics for this scenario.

58. The model was then used to simulate water flows and level fluctuations in the months of February, June, August, and November. Due to the intensity of the modeling exercises, these months are representative of the different seasons, particularly those of biological importance. To evaluate operations during various types of water years, the Applicant conducted the same modeling as developed in study 5 for four different years, representing the years that are statically dry to wet water years. The years were 2009, 2015, 2016, and 2017, with 2009 being the wettest and 2015 being the driest. The model routed water starting at the most upstream portion of the Bellows Falls impoundment to the Bellows Falls dam, roughly 26 miles in length. The water is then simulated to pass through the Project and discharged downstream through the Bellows Falls riverine reach, roughly six miles in length. Each of the simulations were developed at an hourly timestep.

59. There are a variety of metrics that can be estimated when characterizing the downstream flow regime for IEO. These include, but are not limited to, daily minimum flow downstream, mean daily amplitude, and the flashiness of the reach downstream.

60. Using the model outputs provided by the Applicant, the minimum daily flow for each target month and year can be calculated. Those values are then averaged over the target month.

61. To calculate mean daily amplitude, the minimum and maximum daily flow value is first calculated. The difference between those two values is then calculated and averaged over the course of the month.

62. The flashiness metric is calculated by the Richard-Baker Flashiness Index equation (Figure 1) to calculate an index value. This index does not account for interannual variability and higher daily flows when calculating flashiness. This index does, however, account for hourly, or within day, changes in flow. This analysis was calculated on an hourly timestep with the total flow considered over a 24-hour period. Each 24-hour period was then averaged to obtain a monthly value. This was calculated for each year, and scenario provided.

Table I. Metrics used to assess subdaily flow fluctuations based on hourly flow data

Metric	Description	Reference
Richards–Baker flashiness index (RBF)	$R\text{–}B\ \text{Index} = \frac{\sum_{i=1}^{n} 0.5(\lvert q_{i+1} - q_i \rvert + \lvert q_i - q_{i-1} \rvert)}{\sum_{i=1}^{n} q_i}$ where q is hourly flow and n is the number of records over the analysis period (24 h). The index is the path length of flow oscillations (sum of the absolute values of hour-to-hour changes in hourly flows) divided by the sum of hourly flows over each 24-h period.	(Baker *et al.*, 2004)

Figure 1. The equation used to calculate a flashiness index for each year and month provided by GRH. This image can be found in Zimmerman, J.K.H. et al. 2010. Determining the effects of dams on subdaily variation in river flows at a whole-basin scale. River Research and Applications. 26: 1246-1260.

63. While this information is not indicative of the natural flow regime, it does provide estimates of Connecticut River hydrology when omitting influences from Project operations. The value for each of the metrics described above, mean downstream flow, mean daily amplitude, and flashiness, are provided below (Table 3). Additionally, the values below represent the Wilder Hydroelectric Project (FERC No. 1892) operating in IEO mode.

Table 3. Metric for downstream flows below the Bellows Falls Project without project related alterations, or in an inflow equal to outflow mode.

Target Month and Year	Mean Minimum downstream flow	Mean daily amplitude	Flashiness
2009			
February	5739	1770	0.02
June	6789	1516	0.01
August	7611	1221	0.01
November	8791	545	0.01
2016			
February	8440	869	0.01
June	3526	1319	0.02
August	2250	1437	0.03
November	4427	1493	0.02
2017			
February	8377	900	0.01
June	3557	1299	0.02
August	2248	1403	0.03
November	4472	1366	0.02
2015			
February	3781	1341	0.02
June	9903	274	0.00
August	2869	1711	0.03
November	5044	1221	0.02

D. Current Operations and Hydrology

Description of Current Project Operations

64. The Bellows Falls Hydroelectric Project operates in a peaking mode within the bounds of license conditions, agreements, and self-imposed restrictions. Bellows Falls as a license condition is required to pass a flow of 1,083 cfs, or inflow if less, downstream. This flow is typically provided through generation and is typically at least 1,200 cfs. Flow during generation can be up to 11,400 cfs.

65. Project operations are automated and controlled from a consolidated hydro operations control center located in Wilder, Vermont. Because GRH typically operates the Project in a coordinated manner with other GRH hydroelectric generating facilities on the Connecticut River, GRH takes into account variations in electricity demand as well as natural flow in order to maximize the use of available water.

66. The Project bypasses a reach of the Connecticut river approximately 3,500 feet in length. The current license does not require a conservation flow to be passed at the dam into the reach of river bypassed by the Project. However, leakage from the dam typically occurs which provides some flow. The leakage typically ranges from 125 to 300 cfs based on estimates from various studies.

67. Reservoir drawdown rates are typically 0.1 to 0.2 feet per hour depending on inflow and do not exceed 0.3 feet per hour. Approximately 3,000 cfs per hour equates to a 0.1 ft. of elevation and 0.3 ft. per hour represents the maximum station output with little to no inflow. The Bellows Falls Project is authorized to drawdown the impoundment three feet from elevation 291.6 feet to elevation 288.6 feet. However, under normal operations, the impoundment range is typically maintained between 289.6 and 291.4 feet, a 1.8-foot range.

68. The Project maintains self-imposed restrictions beginning on the Friday before Memorial Day, through the last weekend in September. During this period, GRH maintains a reservoir elevation of 289.6 feet from Fridays at 4pm through Sundays at midnight. GRH maintains a similar elevation during summer holidays.

69. The Project is generally operated on a daily run-of-river basis, therefore over the course of a day, the Project passes the daily average inflow. However, on an intraday basis, generation can vary between the required minimum flow and full generating capacity.

70. During high flow events GRH will initiate river profile operations by lowering the water elevation at the dam. There are three stages to river profile operations at Bellows Falls. The table below provides the impoundment elevation at the dam when inflow is within the range (Table 4).

Table 4. River Profile Operations at the Bellows Falls Hydroelectric Project.

6- hour Inflow (cfs)	Maximum Water Surface Elevation at Dam (NGVD29)
<11,000	291.6
11,000 – 20,000	291.1
20,000 – 50,000	290.1 (289.6 if ice is present)

50,000 – 90,000	289.6 and partial stanchion board removal @ 52,000 cfs
>90,000	All gates are open, all stanchion bays removed, WSE rises above 289.6 and is maintained at 290.6 until increase due to inflow.

71. The Project spillway has a maximum discharge capacity of 108,385 cfs at normal full pond with a total Project capacity of 119,785 cfs with discharge through the powerhouse. The flood of record occurred in March 1936 was 156,000 cfs which occurred prior to the development of the U.S. Army Corps of Engineers flood reduction dams along the Connecticut, and the development of Moore dam. Since Moore and other dams began operating the highest flow record at Bellows Falls Project was 103,397 cfs during Tropical Storm Irene in August 2011.

72. The storage capacity at the FMF Project is used during spring runoff to "shave" the maximum anticipated peak flows downstream and refill the impoundments. This operation reduces the potential downstream high flow conditions at the Wilder, Bellows Falls, and Vernon Projects, which are typically spilling, and in the case of Bellows Falls and Vernon Project, may prevent the need to trip the stanchion boards.

Hydrology Current Project Operation

73. There are several metrics that can be used to evaluate the effects of project operations on the hydrology of a river system. Table 1 provides monthly statistics under current operations and Table 3 provides estimates under IEO mode without the effects of current operations. Hydrologic statistics can also be evaluated based on a daily time scale, offering additional information on current operations that averaged monthly metrics would otherwise obscure. Refer to Findings 57-62 for specifics on how these metrics area estimated.

Impoundment

74. The amount of time the water surface elevation of the impoundment is stable at a target elevation under current operations is one metric that can be analyzed. For Bellows Falls, the target impoundment elevation is 291.1 feet. Currently, operations do not require a target elevation, require surface water elevations be maintained within a range. To estimate the impoundment stability metric, an elevation of 291.1 feet was used. Additionally, the metric includes instances when the Project implemented river profile operations as described above. This was estimated by comparing the hourly water surface elevation to within 0.1 feet of the target mean surface elevation and viewing it as a percentage of the entire month (Table 5).

75. The magnitude of fluctuations that may occur within the impoundment provide an indication of the daily variability within the impoundment, in addition to indicating high flow events. These were estimated by calculating the daily minimum and maximum values during the target months and years, then calculating the difference between those values. The total is the average difference over the course of a month (Table 5).

Table 5. Daily metrics of current operations within the impoundment at Bellows Falls Hydroelectric Project for the

periods and months representing dry years to wet years and seasonality.

Target month and year	% time at target SWE	Mean daily change in impoundment elevation (feet)
2009		
February	0.1%	0.99
June	0.8%	1.00
August	2.2%	1.10
November	5.4%	1.21
2016		
February	2.7%	0.77
June	0.0%	0.59
August	5.0%	0.84
November	10.4%	0.96
2017		
February	5.7%	0.96
June	7.8%	0.95
August	22.1%	1.09
November	14.2%	1.00
2015		
February	2.7%	0.73
June	0.7%	3.65
August	5.0%	3.89
November	10.4%	0.94

Downstream Flows

76. The fluctuation of water levels in the Project impoundment equates to changes in downstream flows under current peaking operations. Using the same model generated by the Applicant that developed estimates of water surface elevation, the Applicant also included downstream flows for current operations. There are a variety of metrics that can be estimated to characterize the downstream flow regime. These include, but are not limited to, mean daily amplitude, daily minimum flow downstream, and the flashiness of the reach downstream.

77. Using the model outputs provided by the Applicant, the minimum daily flow below the Project for each month and year were calculated. The values were then averaged over the month (Table 6).

78. Similar to the methodology used to estimate the daily amplitude of downstream flow, the minimum and maximum daily flow value was first calculated. The difference between the two values was taken and averaged over the course of the month (Table 6).

79. The Richard-Baker Flashiness Index equation (Figure 1) was used to calculate an index value. Calculation of the index value was previously described in Finding 62. This metric was

calculated for each year and results are provided in Table 6.

Table 6. Metrics for downstream flows below the Bellows Falls Hydroelectric Project under current operations.

Target Month and Year	Mean Minimum downstream flow	Mean daily amplitude	Flashiness
2009			
February	4098	3217	0.06
June	4585	5266	0.07
August	4955	5460	0.06
November	6482	4465	0.05
2016			
February	9875	6792	0.04
June	2625	4135	0.10
August	1626	4221	0.14
November	2171	5679	0.11
2017			
February	10038	6985	0.04
June	2682	4075	0.10
August	1629	4324	0.15
November	2341	5395	0.11
2015			
February	3163	3561	0.11
June	8238	2760	0.03
August	1276	6415	0.21
November	2278	6139	0.16

Fish Passage Measures

80. By agreement with the Connecticut River Atlantic Salmon Commission (CRASC), the fish ladder upstream is operated in accordance with the fish passage notification schedule issued each year based on the presence of Atlantic salmon at the Vernon hydroelectric project. If required, fish passage flows are provided in the spring when Atlantic salmon are observed at Vernon to July 15 and in the fall from September 15 to November 15, if Atlantic salmon are present about the Project. For upstream fish passage, a flow of 25 cfs is provided through the fishway along with an attraction flow of 55 cfs. A flow of 225 cfs is provided for downstream passage.

81. Since 2016, CRASC no longer requires downstream passage for Atlantic salmon smolts. In previous years when downstream passage was in use, flows were provided via the skimmer gate, and typically ran from October 15 to December 31.

Recreation Measures

82. The Applicant owns and operates four formal project recreation sites associated with the Project. They are the Charlestown boat launch and picnic area, the Herrick's Cove boat launch

and picnic area, the Pine Street boat launch and portage trail take-out, and the Bellows Falls fish ladder and visitor center.

83. A requirement of the previous license was to install signs, lights, sirens, boat barriers, and other applicable devices to warn the public and recreationalists of changes in water levels associated with the Project and to protect and guide individuals using the recreational facilities at the Project.

84. The Applicant maintains a phone line and website to provide generation schedules and real time flow information to boaters, anglers, and other recreational users of the River.

E. Applicant's Proposal

85. The Applicant is proposing a new operational regime where the Project will predominantly operate to maintain a specific water surface elevation at the dam resulting in flow below the Project equal to approximate inflow, but also includes flexible operations under which the Project can deviate from inflow equals outflow and operate out of storage for short periods of time. The proposed operational regime is intended to create a more stable impoundment by reducing the average duration, frequency and range of impoundment fluctuations. In addition, it will also reduce the magnitude and frequency of sub-daily change in discharge from the Project.

86. The Project will operate in an IEO mode the majority of the time under the proposed operating regime while maintaining a specific water surface elevation target of 291.1 feet (NVGD29) at the dam with a target water surface elevation bandwidth of 291.6 ft. and 290.6 feet to account for potential differences between anticipated inflow and the actual instantaneous inflow.

87. A continuous conservation flow of 300 cfs will be passed below Bellows Falls dam into the bypass reach of the Connecticut River. The Applicant proposes to construct and operate a new 680 kW turbine generator at the dam to pass the conservation flow. During maintenance or emergencies, when the unit is not in service, spilling over the dam crest or through gates will provide the required flow to bypass.

88. In addition to IEO operations, the Project will have restricted discretionary Flexible Operation capability allowing it to deviate from IEO with 'transition' operations to operate in a peaking mode for a limited number of hours each month and return to IEO operations. The Project could also suspend IEO operation due to high water operations, or emergency and systems operation, requirements and audits, or non-emergency maintenance requirements. Non-emergency maintenance requirements would require consultation with relevant state and federal resource agencies prior to initiating a necessary deviation and developing a suitable refill plan and schedule.

Inflow Equal to Outflow Operations

89. The majority of the time the Project is proposed to be operated in an inflow equals outflow mode while maintaining a target water surface elevation at the of 291.1 feet. The Applicant proposes a +/- 0.5 feet bandwidth around the target elevation to account for potential differences between anticipated inflow and actual instantaneous inflow at the dam, in addition to potential minor measurement error due to effects such as wave action.

90. To implement IEO operations, the Applicant is proposing to monitor the impoundment for water fluctuations on at least an hourly basis and adjust station discharge as frequently as necessary to maintain the target elevation. This would ensure an accurate water surface elevation and discharge would be calculated based on unit discharge curves and accuracy of the unit controls and the sensitivity of setpoints. The Applicant anticipates that station discharge would change no more than once per hour, unless there are rapid changes in inflow.

91. To protect dwarf wedgemussels (See Rare, Threatened and Endangered Species section for more information) the impoundment will be temporarily lowered for roughly 10-21 days when water temperatures consistently drop from 15 degrees Celsius to 10 degrees Celsius. Once water temperatures are consistently below 10 degrees Celsius, the impoundment will be refilled back to the target elevation.

92. Under the Applicant's proposal IEO operations would be suspended under high water operations, emergency systems operations, requirements and audits.

93. Additionally, the IEO operations may be suspended for needed maintenance. Non- emergency maintenance activities would be completed only after consultation with relevant Agencies, including the Department.

Flexible Operations

94. The Applicant proposes restricted discretionary capability to deviate from IEO and operate out of storage or 'flexible operations' for a limited number of hours each month. The number of hours proposed for flexible operations per month are no more than 65 hours each month for December through March; no more than 10 hours per month April through June; a total of 20 hours for July with no more than 10 hours from July 1 through July 15; no more than 20 hours each month for August through October; and a total of 42 hours for November with no more than 10 hours from November 1 through November 15.

95. During flexible operations, the Applicant is proposing a maximum discharge from the Project that is dependent on calculated inflow. When the calculated inflow is approximately 1,800 cfs or less, the maximum discharge during flexible operations is 4,500 cfs. At times when the calculated inflow is greater than approximately 1,800 cfs, the maximum discharge during flexible operations is 2.5 times the calculated inflow and will not exceed the maximum generation capacity of the Project.

96. During flexible operations, the Applicant will maintain the water surface elevation of the impoundment between 291.1 and 286.6 (msl NGVD 29) from October 1 through May 31, and 291.1 to 290.1 from June 1 to September 30.

97. For accounting the total number of flexible hours, the Applicant proposes that for any flexible event that lasts less than 1 hour, the Applicant will consider the event to have lasted for 1 hour. Should the flexible event last longer than 15 minutes past the following hour than the flexible event the Applicant will consider it to be two hours. The number of flexible hours in a single event does not include the up-ramping hour, down-ramping hour, or number of hours it takes to refill the impoundment.

98. The time that flexible operations end for the purpose of determining the number of allowed

hours which have been used each month is when down-ramping begins. For any flexible event that lasts less than one hour, the Applicant will consider the event to have lasted for one hour. Should the flexible event last longer than 15 minutes past the following hour, then the flexible event has lasted for two hours. The number of flexible hours in a single event does not include the up-ramping hour, down-ramping hour, or number of hours it takes to refill the impoundment.

Transition Operations

99. In addition to flexible operations, the Applicant is proposing 'transition operations' that govern departures from and returns to IEO mode. Transition operations would precede flexible operations in specified instances and follow flexible operations in all cases. These operations include an up-ramping period (for scheduled flexible operations), a down-ramping period, and a refill period.

100. During up-ramping, flow will be increased over a one-hour period prior to a scheduled flexible operation event with the goal of providing a gradual increase in the flow below the Project from IEO to the maximum planned discharge during flexible operations. For the Project, the Applicant proposes to up-ramp at the lesser of 1 cfs/square mile of drainage area (csm) (approximately 5,414 cfs) or the flow half-way between the calculated IEO flow and maximum flexible operation flow.

101. The Applicant's proposal for down-ramping after flexible operations is to decrease flow on an hourly basis, as a percentage of the previous hourly flow. Flow will be decreased no greater than approximately 70 percent of the flexible operation flow and then further reduced approximately 70 percent each successive hour of the previous hourly flow until the discharge from the facility is equal to the calculated inflow at the dam. The duration of down-ramping will be dependent on the maximum discharge during the flexible operations event and inflow into the Project.

102. The Applicant proposes to refill the impoundment to the target elevation within 48 hours after the completion of the down ramping operations. To refill the impoundment the applicant proposes to pass 70 percent of the estimated inflow or seasonal base flow, whichever is greater, while the remaining is stored. The seasonal base flows for the Project are the combined bypass flow and station discharge. Seasonal base flows are 1,600 cfs for October 1 through March 31; 3,000 cfs April 1 through May 31; and 1,400 cfs from June 1 to September 30. Refill operations may be temporarily paused; however, this time will still be considered as part of the 48 hour refill period.

103. The Applicant proposes no limitation on the number of flexible operation events per day or the duration of an event, except the indirect limitations due to inflow and transition operation requirements.

104. All scheduled flexible operations will require one hour of transition operations to up-ramp. No up-ramping is required for unscheduled flexible operations. All flexible operations events will require transition operations for down ramping and refill. The table below specifies the applicability of transition operations for various Project operations (Table 7).

Table 7. GRH proposal for application of transition operations (up-ramping, down-ramping and impoundment

refill) associated with flexible operations of the Bellows Falls Hydroelectric Project.

	Up- Ramping	Down- Ramping	Impoundment Refill
Flexible Operations, Scheduled	Applied during the hour prior	Applied as Defined	Applied as Defined
Flexible Operations, Un-Scheduled	Not Applied	Applied as Defined	Applied as Defined
High Water Operations	Not Applied	Not Applied	Not Applied
CCA and RPD audits*	Not Applied	Applied as Defined	Applied as Defined
Emergencies and System Emergencies	Not Applied	Not Applied	Not Applied

*Claimed Capacity Audits (CCA) and Reactive Power Demonstrations (RPD). These tests are required as part of participating in portions of the ISO New England power market.

105. If more than two CCA tests per year are needed, the Applicant will notify the Department that it must conduct additional tests and the number of flexible operation hours for each additional test will be determined as described above and counted either in the current or in the next month's allocation, if none are available in the current month.

Hydrology of Proposed Operations

106. Similar to current operations, a number of metrics can be calculated to evaluate how the Applicant's proposed operations will affect the hydrology of the Connecticut River. The same model used to generate numerous metrics for current Project operations was used by the Applicant to charachterize proposed operations. The model uses the same intensive HEC-RAS model with inputs from known operations, water surface elevation data collected at various nodes within the impoundment and downstream of the facility, inflow estimates, and generation data to estimate Project effects. The model used the same approach as described in findings 57-62.

Impoundment

107. The same metrics and methodology used to charachterize current operations was also applied to the proposed operations (Findings 74-75), and those are provided in Table 8.

Table 8. Daily metrics of proposed operations within the impoundment at Bellows Falls Hydroelectric Project for the periods and months representing dry years to wet years and seasonality.

Target month and year	% time at target SWE	Mean daily change in impoundment (feet)
2009		
February	54%	0.40
June	92%	0.11
August	92%	0.09
November	94%	0.05
2016		

February	40%	0.52
June	99%	0.03
August	76%	0.20
November	65%	0.36
2017		
February	55%	0.44
June	93%	0.09
August	73%	0.25
November	74%	0.24
2015		
February	40%	0.51
June	96%	0.04
August	77%	0.20
November	67%	0.35

Downstream flows

108. In addition to water level fluctuation in the impoundment, the Project will regulate downstream flow during the flexible and transition modes of the proposed operation. Using the HEC-RAS model that allowed for estimates of metrics related to water surface elevation, the Applicant also estimated metrics to characterize the downstream flow regime for proposed operations.

109. The same methodology presented in Findings 76-79 was used to generate metrics for flows downstream of the Project. These metrics are presented in Table 9 for each target year and month.

Table 9. Metrics for downstream flows below the Bellow Falls Hydroelectric Project for the periods and months representing dry years to wet years and seasonality under the Applicant's proposal.

Target Month and Year	Average Minimum downstream flow	Mean daily amplitude	Flashiness
2009			
February	4709	4877	0.08
June	6789	1746	0.02
August	7391	1653	0.02
November	8622	916	0.01
2016			
February	8249	1646	0.02
June	3415	1643	0.03
August	2127	1770	0.05
November	3902	3713	0.06
2017			
February	8179	1704	0.02
June	3446	1623	0.03

August	2125	1770	0.05
November	3948	3586	0.06
2015			
February	2829	5465	0.13
June	9974	202	0.00
August	2495	3238	0.07
November	4234	3894	0.06

Fish Passage Measures

110. The Applicant proposes to implement the fish passage settlement agreement (Agreement) executed on August 8, 2022. Parties to the agreement include GRH, USFWS, New Hampshire Fish and Game Department, and Vermont Fish and Wildlife Department. The portions of the agreement relevant to the Project are summarized below.

111. The Applicant proposes to develop a Fish Passage Management Plan for the Project in consultation with the Agency and submit to FERC for approval within 120 days after issuance of a new license.

112. The Applicant proposes to operate upstream fish passage measures at the Project from April 1st through July 15th upon license issuance.[5] The April 1st start date is to accommodate early spring spawners such as walleye and white suckers. Dedicated American eel passage will be provided from May 1st to November 15th upon completion of the implementation of enhancements as set forth in the fish passage settlement agreement. The Applicant also proposes to operate downstream fish passage measures from August 1st through December 1st upon completion of the implementation of enhancements as set forth in the fish passage settlement agreement.

113. The Applicant notes that the fish passage measures are intended to provide safe, timely, and effective passage for target migrating species (American eel and sea lamprey). For all identified fish passage measures, the first year of operation shall be used to assess if all components of the fish passage facility are operating as intended. The following two years will be used to quantitatively assess the effectiveness of the fish passage design with studies. Additional years of study may be needed if modifications are needed or if a study season is anomalous. Conversely, a single representative study may be adequate if results clearly indicate measures are effective and agreed to in writing by the Agencies.

114. The Applicant is proposing to consult with relevant agencies and reach agreement on study plan designs and schedules.

115. The Applicant is proposing to consult with relevant agencies and seek approval for fish passage designs. The designs shall meet the USFWS Design Criteria to the extent that they are practicable in regard to engineering principles.

[5] The April 1 start date is to accommodate early spring spawners such as walleye and white suckers only. The fish ladder at Bellows Falls shall commence operation as close as possible to April 1 annually, but no later than April 15 as long as ice conditions and/or debris conditions allow for fish ladder inspections and the ladders are fully operational.

116. The Applicant supports the removal of the barrier dam also known as the "Salmon Dam" located within the bypassed reach of the Connecticut River.

Downstream passage

117. In years three and four after license issuance, the Applicant is proposing to undertake a hydraulic study or suitable alternative, designed to inform downstream passage and design options to achieve safe, timely, and effective passage for American eel.

118. The Applicant is proposing to initiate consultation with the agencies on study design no later than January 1st of license year sixth with the report completed by end of license year seven. Additionally, the Applicant is proposing to initiate consultation on the design with the Agencies no later than January 1st of license year eight with the final design plans due by the end of license year nine.

119. The Applicant is proposing to initiate construction of approved downstream eel passage and protection measures no later than July 16th of license year ten, with the aim to complete the project by the end of license year eleven, and the passage facility fully operational no later than August 1st of license year twelve.

Upstream passage

120. In years two and three after license issuance, the Applicant proposes to monitor American eel and sea lamprey use of the fish ladder from April 1st to July 15th. In year four, the Applicant is proposing to undertake a study using Passive Integrated Transponder (PIT) tag technology to assess passage performance of American eel and sea lamprey within the fish ladder, with the potential to do another year of study in year five.

121. If it is determined necessary based on the PIT study, the Applicant proposes to conduct a hydraulic study and engineering assessment of the existing fish ladder to inform potential modifications to improve passage effectiveness for American eel and sea lamprey. If needed, the final report on the study will be completed no later than the end of license year six.

122. If needed, the Applicant proposes to implement consultation on design no later than January 1st in the seventh-year post license issuance, and any modification will be completed no later than December 31st of the ninth year after license issuance.

123. The Applicant is proposing to design, construct, operate, and maintain interim measures approved by the agencies to pass American eels upstream for the period of July 16th through November 15th. The interim measures shall be completed no later than July 15th of the fourth year after issuance of the license. In the first two years of interim passage operations eel passage will be monitored and reported to agencies to determine effectiveness.

124. The Applicant proposes no later than July 1st of year nine of post license issuance to initiate consultation with the agencies to determine if the existing information is sufficient to identify necessary locations for permanent upstream eel passage measures. Should no additional studies be needed, the Applicant is proposing to complete final designs for permanent upstream passage. The Applicant proposes to complete construction and have the passage fully operational no later than July 16th of the eleventh year after license issuance.

125. Should additional studies be needed, the Applicant proposes to initiate the final designs no later than December 31st of the eleventh year. The construction of the permanent passage would be completed and operational no later than July 16th of the twelfth year after license issuance.

126. Additionally, the Applicant in proposing to assess the need for American eel passage in the Bellows Falls bypass reach and dam with consultation being initiated with the agencies on an eel survey no later than July 1st of the year the barrier dam is removed or license year six, whichever is later. Should the results indicate an area of eel concentration in the vicinity of the spillway, the Applicant proposes to install a single upstream eel passage facility within the bypass reach. The Applicant is proposing to consult with the Agencies on the final design plans with the operations of the bypass eel passage no later than May 1st of the third year following the eel survey or license year ten depending on the trigger.

Installation of a minimum flow turbine

127. The Applicant is proposing to install a new 680-kW minimum flow turbine generator and control house and electrical interconnect equipment at the Bellows Falls dam on the Vermont side. The minimum flow unit will be used to pass the proposed 300 cfs to the Bellows Falls bypass reach. The unit is estimated to have a maximum hydraulic capacity of 345 cfs.

128. The turbine generator will be housed in a concrete intake structure connected to the downstream face of the spillway at stanchion bay #1 of the dam. The design of the concrete intake structure will include three new spill conveyance structures, comprised of a 25-foot wide vertical crest gate, a 14-foot wide downward opening, a bottom hinge crest gate and a 14-foot wide bay of removable stoplogs which will have a combined capacity of 5476 cfs and will increase the spillway capacity by 465 cfs.

129. The concrete intake structure will include a horizontal trash rack measuring approximately 33 feet wide by 30 feet long with 2-inch clear spacing between the racks. The average velocity through the entire rack is calculated to be 0.97 feet per second (fps). The average velocity through the rack in the area concentrated around the unit itself will be approximately 1.88 fps.

130. The turbine will utilize adjustable-pitch wicket gates to allow ramping of output power. An existing auxiliary steel bulkhead used to repair and maintain stanchion sections of the dam will continue to be used as a means of blocking flow to the intake structure and turbine for construction, inspection, and service or repair.

131. The turbine will utilize an elbow draft tube (horizontal outlet) with steel liner supplied by Natal. Construction of the intake structure is expected to occur one year after issuance of the FERC license with the unit being commissioned by year two.

132. The Applicant is proposing to conduct a post-commissioning evaluation of the turbine survival and injury for adult American eel. The study plan will be developed in consultation with and approved by state and federal fisheries agencies prior to completing construction. The intent is to conduct the study in the first downstream passage season following commission of the unit.

Additional Proposed Measures

133. The Applicant proposes several specific improvements to recreation facilities associated with

the Project including at Harricks Cove recreation site to improve dock, parking, and picnic sites; expand car top launches; and bird observation platform and trails. At the Pine Street boat launch, GRH is proposing to improve the boat launch, parking, and picnic sites; repair and re-purpose red barn for portage support; and provide a portage transportation service around the Project. Additionally, improvements proposed for the Charlestown recreation site include improving parking and picnic sites. The boat launch was previously improved in 2018 by the Applicant. Other recreation enhancements being proposed are improvements to the Visitor Center and improvements and rehabilitation of the canoe camp site.

134. The Applicant proposes to maintain and enhance the existing recreational areas at the Project as needed. The applicant is proposing to maintain its online and phone system to provided users of the river with streamflow information and scheduled generation from the Project. In addition, the Applicant is proposing to develop a recreation management plan after license issuance in consultation with applicable state agencies and will submit the Plan for FERC approval.

135. The Applicant proposes to continue to manage undeveloped lands with cooperative agreements with farmers to maintain agricultural land while also managing critical bird nesting habitat. Additionally, the Applicant is proposing to develop a land use management plan in consultation with a grassland bird biologist and natural resource agencies within one year of issuance of the FERC license.

136. The Applicant proposes to develop an agreement for managing historic resources with the state historical preservation office in consultation with Abenaki tribal leaders.

137. The Applicant proposes to design, install and implement tools, equipment, and resources as needed, within the Project boundary, portions of the river affected by project operations, and in the operations control center to assist in inflow monitoring, inflow forecasting and managing the impoundment to the target water surface elevation in order to successfully operate the Project under the proposed operation.

F. Current Status of Waters in the Project Area

138. In August 2022, the U.S. Environmental Protection Agency approved a list of waters considered to be impaired based on water quality monitoring efforts and in need of total maximum daily load (TMDL) development to address pollution. The Department submitted the list under section 303(d) of the Federal Clean Water Act.

139. According to the State of Vermont's 2022 303(d) list of impaired surface waters, there are waters within or near the project areas listed for various reasons. However, these listings are on tributaries and generally due to stressors unrelated to the operation of the Project.

140. The Connecticut River in the vicinity of the Bellows Falls Project area is not listed as an impaired surface in need of a TMDL, an impaired water where no TMDL is required, or as an impaired water with a TMDL.

141. The Department concurrently issued as a four-part list, List of Priority Surface Waters Outside the Scope of the Clean Water Act Section 303(d) in 2022. These waters correspond to Category 4C of the EPA's Consolidated Assessment Listing Methodology. To the extent that these listings may be affected by the Applicant's proposal, these waters are described below.

142. The reach of the Connecticut River that is impounded by the Bellows Falls Dam is listed as a priority water on Part F due to water level fluctuations associated with Project operations that results in unstable/eroding streambanks upstream of the dam. The Connecticut River is also listed on Part F below Bellows Falls Dam due to artificial flow, fluctuations associated with hydropower production.

143. The Connecticut River is listed as a priority water in Part E above Bellows Falls dam for locally abundant Eurasian Watermilfoil growth (*Myriophyllum spicatum*).

144. The Agency's publication *Hydropower in Vermont, An Assessment of Environmental Problems and Opportunities* is a state comprehensive plan.[6] The plan indicated that hydroelectric development has a significant impact on Vermont streams, as power projects are usually located on important scenic and ecological sections of streams. Artificial regulation and diversion of natural stream flows were found to have largely reduced the success of state initiatives to restore the beneficial values and uses for which the affected waters are managed under the federal Clean Water Act and Vermont law.

145. The Project area is partially located within Basin 10 and Basin 11 of the Agency's Tactical Basin Planning framework. The applicable tactical basin plans include Basin 10, which encompasses the Black and Ottauquechee Rivers and the Connecticut River direct tributaries, as well as Basin 11 which includes the West, Williams, Saxtons Rivers, and the Lower Connecticut River direct drainages. Both plans are state comprehensive plans to identify and address water quality issues in the basins.[7] The tactical basin plan notes the development of the Long Island Sound TMDL. In 2013, a Vermont specific section listed four goals; to identify the Vermont sources of nitrogen as they are currently understood, across broad land use sectors, such as developed, agricultural and forested; to identify the status trends of important drivers of nitrogen export such as the intensity of agricultural and development activities and investigate how these might have changed since the TMDL baseline period of 1990; to identify the management programs, operating at that time, that address these drivers of nitrogen loading that have a significant effect on reducing or preventing nitrogen export; and using a weight-of-evidence approach, to assess the combined management programs/projects to develop a qualitative evaluation as to whether management efforts are sufficient to meet the original 2000 TMDL of a 10 percent non-point source nitrogen reduction and if these strategies are sufficient to maintain that control into the future.[8]

146. It is estimated that 12.5 percent of the total nitrogen load comes from Basin 10 of which approximately 64 percent is due to atmospheric deposition and it estimated that 16 percent of total nitrogen comes from Basin 11, of which 71 percent is due to atmospheric deposition. Efforts to reduce this form of nitrogen are occurring through the 1990 Clean Air Act and its applicable amendments. Additional measures to reduce sources of nitrogen in Vermont Basins 10 and 11 include nitrogen reductions from wastewater discharges, agricultural lands, and developed lands.

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[6] DesMueles and Parks. 1988. Hydropower in Vermont. An assessment of Environmental Problems and Opportunities. Vermont Department of Environmental Conservation. Montpelier, Vermont.

[7] Vermont Department of Environmental Conservation. 2023. Black & Ottauquechee Rivers & Connecticut River Direct Tributaries Basin 10 Tactical Basin Plan. Montpelier, Vermont. September 2023.

Vermont Department of Environmental Conservation. 2021. West, Willams, & Saxtons Rivers & Lower Connecticut River. Basin 11 Tactical Basin Plan. Montpelier, Vermont. December 2021.

[8] Vermont Enhanced Implementation Plan for the Long Island Sound TMDL.

147. Strategies within tactical basin plans 10 and 11 include; coordination with agricultural service providers to determine there is a gap in outreach and implementation of water quality best management practices along the Connecticut river, identificication of priority wetland restoration sites in agricultural fields, expanison and protection of riparian buffers within the FERC jurisdictional impoundment associated with Bellows Falls dam, increasing conservation flows below the Bellows Falls Dam and reducing the magnitude of peaking operations and water level fluctuations in the impoundment which would improve aquatic habitat in the Connecticut River, and providing outreach, technical assistance, and workshops to private forestland owners on best management practices.

148. The 2015 Wildlife Action Plan is another applicable state comprehensive plan.[9] The plan includes species of greatest conservation need located within the Project vicinity. These species include: Sea Lamprey (*Petromyzon marinus*) in the Connecticut River drainage, American eel (*Anguilla rostrata*), Cobblestone tiger beetle (*Cicindela marginipennis*), and dwarf wedgemussel (*Alasmidonta heterodon*). The plan identifies high and medium priorities for these species. Additional information on each specific species is discussed later in the applicable section of this water quality certification (e.g. Rare, Threatened, and Endangered Species and Aquatic Biota).

G. Water Chemistry

149. There are numerous wastewater facilities located on the Connecticut River that require a National Pollutant Discharge Elimination System (NPDES) permit. A total of 64 discharges are located in Vermont and New Hampshire above the Wilder, Bellows Falls, and Vernon Hydroelectric projects. There are 45 wastewater treatment discharge facilities located upstream of the Project.

150. The Project currently has a NPDES permit issued by the Vermont Department of Environmental Conservation to discharge minor, non-generation related wastewaters, which includes non-contact cooling water. The permit requires a quarterly sampling effort for temperature, pH, oil or grease. Throughout the required monitoring period, required permit levels have not been exceeded.

151. There are 19 wastewater treatment facilities in the Connecticut River watershed between the Wilder Project and Bellows Falls Project. These locations are Charlestown NH, Claremont NH, Guild NH, Lebanon NH, Meriden NH, Newport NH, Springfield NH, Sunapee NH, West Lebanon NH, Bethel VT, Cavendish VT, Chelsea VT, Hartford VT, Ludlow VT, and Windsor VT.

152. As part of the relicensing process, the Applicant conducted water quality sampling in two efforts, the first in 2012 and the second in 2015. As part of the 2012 baseline study, dissolved oxygen (DO), temperature, specific conductivity, pH, and nutrients and chlorophyll-a were collected at various locations. Data was collected during the summer and was representative of a low-flow, warm weather period at five locations within the Project area: upper Bellows Falls impoundment, middle impoundment, forebay, tailrace (below dam and powerhouse), and bypass reach. In addition, to the variables listed above, vertical profiles were collected within the impoundment.

[9] Vermont Fish and Wildlife Department. 2015. Vermont's Wildlife Action Plan. Montpelier, Vermont.

153. The 2015 study followed a similar methodology as in 2012, but additional variables were collected. These included turbidity monitoring, continuous recording of water temperature at all stations, addition of a riverine station upstream of the upper extent of the impoundment, and continuous water temperature monitoring in the White River, Mascoma River, Sugar River, Black River, Williams River, Saxtons River and Cold River.

154. The goal of these studies was to collect data during low flow, high temperature periods for a minimum of 10 days while the Project was operating. The Project was operated in a store and release hydropeaking mode as authorized under the current license during the water quality monitoring studies conducted 2012 and 2015.

155. In 2012, temperatures gradually warmed and peaked in mid-August, which would be expected for this region. Temperatures in the forebay, bypass reach, and tailrace ranged from 21.0 °C to 27.0 °C, 20.9 °C to 27.2 °C, and 21.0 °C to 26.3 °C, respectively, over the study period. Overall, the temperature in the mainstem ranged from 18.7°C (upper impoundment) to 27.0°C (forebay), the lowest occurred in the upper impoundment at 17.3°C over the course of the study. The minimum DO level was 3.3 mg/L or 39 percent saturation, in the forebay which corresponded to stratification within the water column.

156. During the 2015 water quality monitoring study, instantaneous sampling for temperature occurred from late April through November 15. Over the course of the sampling water temperatures ranged from 5.8 °C to 26.3 °C and were on average cooler at the upstream riverine reach, and warmest at the forebay and tailrace.

157. Dissolved Oxygen (DO) was continuously monitored in the forebay, bypass reach, and tailrace of the Project. During the 10-day, high-temperature, low-flow monitoring period, DO was measured at all mainstem stations. DO levels were relatively high in June then decreased through the summer and began to increase again in September. DO levels ranged from 7.1 to 10.7 mg/L and 84 to 118 percent saturation with the lowest DO levels being observed in August and September.

158. Within the mainstem, vertical profiles indicated that throughout the Bellows Falls study area from June to October the water column was generally uniform with some surface warming during the summer but was well oxygenated. No stratification was observed in the forebay during 2015. A brief period of stratification was observed at the middle of the impoundment station. No other instance of stratification was observed during the monitoring study and DO remained above State standards (Table 10).

Table 10. A summary of the vertical and continuous statistics for locations within the Bellows Falls Project area of dissolved oxygen concentration and saturation collected during the 2015 water quality study. Maximum (max), Minimum (min) and Mean or average values are provided.

Locations	Dissolved Oxygen (mg/L)			Dissolved Oxygen (% saturation)		
	Max	Min	Mean	Max	Min	Mean
Vertical profile locations						
Upstream Riverine	10.4	8.1	9.1	109	93	102
Upper Impoundment	10.1	7.9	9.0	107	92	100
Middle Impoundment	10.1	7.9	8.9	117	91	100
Forebay	10.0	7.1	8.4	111	85	95

Tailrace	10.1	8.0	9.0	110	93	104
Continuous monitoring						
Forebay	10.0	7.1	8.5	115	84	87
Bypass Reach	10.3	8.0	8.9	108	97	99
Tailrace	10.7	7.2	9.0	118	85	88

H. Aquatic Biota

159. "Aquatic Biota" means all organisms that, as part of their natural life cycles, live in or on waters. (Standards, Section 29A-102(5)). Aquatic biota includes fish, aquatic invertebrates, amphibians, and some reptiles such as turtles.

160. The Connecticut River is classified by the State of Vermont as Class B(2) for the aquatic biota designated uses and is designated as a cold water fish habitat.

161. There is a diverse assemblage of resident fish species located in the Bellows Falls impoundment and the riverine reach downstream from the dam. Some of the species include White Sucker (*Catostomus commersonii*), Bluegill (*Lepomis macrochirus*), Largemouth Bass (*Micropterus salmoides*), Smallmouth Bass (*Micropterus dolomieu*), Rock Bass (*Ambloplites rupestris*), Slimy Sculpin (*Cottus cognatus*), Blacknose Dace (*Rhinichthys atratulus*), Bluntnose Minnow (*Pimephales notatus*), Common Shiner (*Luxilus cornutus)*, Creek Chub (*Semotilus atromaculatus*), Fallfish (*Semotilus corporalis*), Golden Shiner (*Notemigonus crysoleucas*), Longnose Dace (*Rhinichthys cataractae*), Spottail Shiner (*Notropis hudsonius*), Chain Pickerel (*Esox niger*), Northern Pike (*Esox Lucius*), Banded Killifish (*Fundulus diaphanous*), Tessellated Darter (*Etheostoma olmstedi*), Walleye (*Sander vitreus*), Yellow Perch (*Perca flavescens*), Rainbow Trout (*Perca flavescens*), and Brown Trout (*Salmo trutta*).

162. In addition to the resident fish species, some diadromous fish species such as the American eel and Sea Lamprey are found upstream and downstream of the Project. In addition, American shad migrate to spawning areas below the Project, and have been observed utilizing the Bellows Falls fish ladder during certain years. However, the Bellows Falls is believed to be the historic extent of American shad, as the steep falls, where the dam is now located, are considered a natural barrier.

163. The Vermont Fish and Wildlife Department does not currently stock any species directly into the Connecticut River. However, tributaries to the Connecticut River in the vicinity of Bellows Falls, for example the Black River, are stocked with brown and rainbow trout.

164. Additional biota located in the Project area typically associated with the benthic zones include macroinvertebrates and mussels. The mussel species include Eastern elliptio (*Elliptio complanate*), Eastern lampshell (*Lampsilis radiata*), creeper (*Strophitus undulatus*), traingle floater (*Alasmidonta undulata*) and dwarf wedgemussel.

165. Additional aquatic biota likely in the Bellows Falls Project affected area include beaver, muskrat, mink, otter and a variety of frogs, and likely some turtles.

166. Applicable fishery management goals for the Connecticut River around Bellows Falls include restoration for American eel by improving flow regimes below hydroelectric generations,

increasing and/or maintaining available habitat in terms of quantity and quality required for all life stages, restoring fish passage at dams to provide safe, timely and effective upstream and downstream fish passage, and operation and maintenance of existing fishways for peak passage performance.

Protection measures for aquatic biota

167. Downstream fish passage at the Project consists of a forebay sluiceway/skimmer gate and a solid, partial depth diversion boom. While downstream fish passage is currently present, it is designed and operated for Atlantic Salmon smolts. Downstream passage at Bellows Falls has not been provided since 2016 and therefore entrainment, and potential for injury and mortality, likely occurs at the Project.

168. As part of the relicensing the Applicant conducted a fish impingement and entrainment study (Study 23). The study used existing information including, but not limited to known turbine specifications, fish species life histories, fish species general habitat preferences, resident species assemblage (Study 10), and the Electric Power Research Institute (EPRI) database.

169. The fish assemblage study was used to select target species from the Bellows Falls impoundment. The target species were narrowed down to represent various major family groups and trophic guilds, representing species occupancy in all areas of the water column. Resident target fish species for the study include, White Sucker, Bluegill, Largemouth Bass, Smallmouth Bass, Fallfish, Golden Shiner, Spottail, Shiner, Northern Pike, Tessellated Darter, Walleye, Yellow Perch, and Brown Bullhead (*Ameiurus nebulosus*). American eel was also included in the impingement and entrainment analysis.

170. One measure of the ability of a fish to swim quickly for short distances or time intervals of less than 15 seconds is commonly referred to as burst speed. An individual's burst speed depends on the species and size of the individual. This measure is related to a fish's ability to capture prey, avoid predators, or in the case of hydroelectric facilities, avoid water intake velocities at the trashracks. Burst speeds have been estimated in the literature and are often presented as a range.

171. Additional measures of the swimming ability of a fish are sustained or the ability to swim potentially indefinitely and prolonged, a fishes ability to swim for shorter periods of time but longer than those initial bursts of temporary speed. The Applicant reviewed the scientific literature and the EPRI database to develop a range of fish swim speeds of the species of interest (Table 11).

Table 11. Various swimming speeds of target species and life stages for estimation of entrainment. Burst speed typically is the speed a fish can swim for less than 15 seconds. A prolonged speed can be sustained by a fish between 15 and 200 seconds. A sustained speed is the speed a fish can swim indefinitely. Speeds are presented in either feet per second (f/s) or centimeters per second (cm/s). Additional literature data include speed per fishes body length was omitted for clarity, although it appears the range of values is representative.

Species	Life stage	Body length (inches)	Sustained	Prolonged	Burst Speed
American eel	Juvenile (elver)	2.8-3.9			2-3 (f/s)
	Juvenile (yellow)	14.0-21.0		1.4 (f/s)	
	Adult (silver)	12.5-27.6		2.2 (f/s)	
White Sucker	Juvenile/Adult	6.7		48-73 (cm/s)	

	Adult	15.4-15.7			11.5-14.8 (f/s)
Largemouth Bass	Fry	0.8-0.9		408-31.2 (cm/s)	
	Juvenile	2-10.6	0.79-1.34 (f/s)	30.6-60 (cm/s)	
Smallmouth Bass	Fry	0.6-1		0.6-0.89 (f/s)	
	Juvenile	3.6-3.7		1.3-1.8 (f/s)	
	Adult	10.5-14.9		1.6-3.9 (f/s)	
Bluegill	Juvenile	0.8-2.2		0.33-28.1 (f/s)	
	Adult	3.9-6		37 (cm/s)	4.3 (f/s)
Pumpkinseed		5		37.2 (cm/s)	
Fallfish	Juvenile/Adult	7.1-11.8		0.2-1.1 m/s	
Golden Shiner		1.8-2.7		31.7-43.4 (cm/s)	
Spottail Shiner	Juvenile	2		21.05-22.5 (cm/s)	
Northern Pike		4.7-24.4		21.05-148(cm/s)	NA
Brown Bullhead	Juvenile	2		32 (cm/s)	360-450 (cm/s)
Channel Catfish	Juvenile	6.3-8.3	1.3 (f/s)	2.9 (f/s)	3.9 (f/s)
Yellow Perch	Larval	0.6-1.4		0.6-4.6 (cm/s)	
	Juvenile	3.7-4.1		15.5-33.5 (cm/s)	
Walleye	Fry	0.5-0.8	0.16-0.25 (cm/s)		
	Juvenile	3.2-6.3		38 -138 (cm/s)	
	Adult	15.4-22.4	84(cm/s)	261 (cm/s)	
Tessellated Darter		1.6-3.1		37.76 (cm/s)	

172. In addition to understanding the target species burst speed, calculating the velocity through the trashracks is also required. The through rack velocity was calculated assuming the maximum turbine discharge. For the Project, Units 1, 2, and 3 have a calculated intake velocity of 2.2 fps.

173. Fish impingement describes the action of a fish being held in contact with a trashrack or screen. The ability of a fish to get impinged depends on the width of the species and the spacing between trashrack bars, or clear bar spacing. The clear bar spacing at Bellows Falls for all three units is 4 inches.

174. Of the fourteen target species examined at their representative lengths, adult northern pike and walleye were the only species with a body length of greater than 30 inches and reached a calculated body width wider than the trashrack spacing of 4-inches which can make them vulnerable to impingement.

175. If an individual fish is unable to escape the through rack velocity and is small enough to avoid impingement, it may become entrained, meaning it could enter the turbines. The survival of the fish through the turbines depends on the length of the fish and the type and speed of the turbine.

176. There are three identical vertical Francis turbines at the Project. The following table (Table 12) provides an estimate of survival of fish of differing lengths that pass through the turbines. The

blade strike potential and estimated survival rates were calculated for the three units at maximum unit discharge, at peak unit efficiency, and at minimum flow using the methodology from Franke et al. (1997).[10]

Table 12. Estimate of survival rates for fish of differing sizes that potentially become entrained in turbines at the Bellows Falls Hydroelectric Project.

Fish length	Vertical Francis Turbine
4-6 inches	87 – 97%
15 inches	52 – 88%
30 inches	52 – 88%

177. The likelihood of a fish becoming entrained depends not only on the size of the individual but also on its expected life history and on where it typically reside within the riverine system, including depth and mesohabitat types. A multi-step qualitative assessment was performed using the EPRI database to determine the potential for a fish becoming entrained from low to high.

178. Examples of the factors considered in the five-step qualitative assessment were the number of obligatory migrant species present at the Project, the location and depth of the trashracks, in addition to the approach velocities, the location of the intakes relative to shoreline or littoral zone, and behavioral characteristics of fish species, including swim speed.

179. Table 13 summarizes the potential for the target fish species and life stages to be entrained at the Project from low to high.

Table 13. The potential for a fish species and life stage to become entrained in the Bellows Fall Hydroelectric Project turbines based on factors evaluated for each species and life stage type. Rating for the potential entrainment is Low (L), Medium (M) or High (H).

Species and Lifestage	Habitat and life history relative to Project characteristics	Swim speed relative to Approach Velocity	Other Projects (EPRI 1997)	Overall Entrainment Potential
American Eel				
Juvenile	L	M	L	M-L
Adult	H	L	H-M	H
Bluegill				
Juvenile	M	H-M	H-M	H-M
Adult	L	M-L	M-L	M-L
Brown bullhead				
Juvenile	L	H	H-M	M-L
Adult	L	L	M-L	L
Fallfish				
Juvenile	L	L	L	L
Adult	L	L	L	L

[10] Franke, G., D. Webb, R. Fisher, D. Mathur, P. Hopping, P. March, M. Headrick, I. Laczo, Y. Ventikos, F. Sotiropoulis. 1997. Development of environmentally advanced hydropower turbine system concepts. Idaho Falls, ID: US Department of Energy. Report No. 2677-0141. Prepared for Voith Hydro

Goolden Shiner				
Juvenile	H	H-M	H-M	H-M
Adult	M	ND*	L	M-L
Largemouth Bass				
Juvenile	M	M-L	H-M	M
Adult	L	M-L	M-L	M-L
Northern Pike				
Juvenile	L	L	M-L	L
Adult	L	L	M-L	L
Sea Lamprey				
Juvenile	M	H-M	L	M-L
Adult	L	ND*	L	L
Smallmouth Bass				
Juvenile	M	H	M	M
Adult	L	H-M	M-L	M-L
Spottail Shiner				
Juvenile	H	H	H-M	H-M
Adult	M	H	H-M	H-M
Tessellated Darter				
Juvenile	L	M-L	M-L	M-L
Adult	L	M-L	M-L	M-L
Walleye				
Juvenile	M	M-L	H	H-M
Adult	M	L	M-L	M-L
White Sucker				
Juvenile	M	M-L	H-M	M
Adult	L	L	M	M-L
Yellow Perch				
Juvenile	M	M-L	H	H-M
Adult	L	M-L	M-L	M-L

*ND indicates no data

180. The Applicant is proposing to install a minimum flow unit at the dam to pass the 300 cfs conservation flow. The proposed turbine generator is a Natal Energy's Restoration Hydro Turbine. The turbine design has been shown to successfully pass American eel at survival rates up to 100 percent with no major internal or external injuries present after a holding period.[11] Additionally, the Applicant is proposing to screen the intake with 2-inch clear bar spaced trash racks with a velocity of 0.97 to 1.88 fps depending on area of calculation (See Finding 128).

I. Fish Passage

[11] Watson, S., A. Schneider, L. Santen, K.A. Deters, R. Mueller, B. Pflugrath, J. Stephenson, Z.D. Deng. 2022. Safe passage of American eels through a novel hydropower turbine. Transactions of the American Fisheries Society Volume 151 Pages 655-746.

181. There are both upstream and downstream fish passage facilities at the Project. The upstream fish passage was completed and commenced operation in 1984 as part of a settlement agreement. Permanent downstream fish passage was provided when the Applicant entered an Memorandum of Understanding with CRASC. The operating schedules of both the upstream and downstream passage are provided by CRASC each year. In the original agreement, operation and design of of the passage facilities, had been based upon the presence of Atlantic salmon either above or below the Project. Since the ending of the Atlantic salmon restoration program in 2013, the fish ladder is operated when sea lamprey are observed at the Vernon Hydroelectric Project. Downstream fish passage has not been provided since 2016.

Upstream

182. The upstream fish passage system at the Project is described in Findings 38 through 43. The current fish passage was designed to pass Atlantic salmon. However, the Atlantic salmon restoration program for the Connecticut River was discontinued in 2012. Currently, there are other migratory species in the Connecticut River. Obligate migratory species needing to pass the Project include American eel and sea lamprey.

183. As part of the relicensing process, the Applicant conducted severalof studies on upstream fish passage. One study was specific to American eel (Study 18). The goal of the study was to collect baseline data on American eel attempting to move upstream past the Project. The methods included visual nighttime surveys within the tailrace, bypass reach and the spillways, in addition to setting baited eel pots in specific locations.

184. Visual surveys were conducted once a week from May 2015 to October 2015. One eel was observed during the 24 weekly surveys at a site near the fish ladder entrance.

185. Eel pots were deployed starting from May 2015 and continued through August 2015. During the effort, two eels were caught. One eel was caught in the fish ladder and the other was caught in the bypass reach near a collection of rocks below the dam.

186. Additionally, the Applicant conducted a monitoring study of the resident and migratory fish species using the upstream fish passage facility at the Project (Study 17). The study involved continuous monitoring of the upstream fish ladder using a camera and motion activated software. The upstream fish passage facility was operated from ice out to ice in. The goal of the study was to capture all movement during the open water period and assess the fish ladder usage for periods of high use by either resident or diadromous species.

187. During the study, the target diadromous species that were recorded using the fish ladder were American eel, American shad, and sea lamprey. Although not recorded, it was assumed that at least one Atlantic salmon successfully passed Bellows Falls based on the observation at the Wilder Project upstream. Additionally, while American shad were observed using the ladder, they are not a target species for upstream passage at the Project because Bellows Falls is believed to be the upstream historic extent American shad.

188. The study targeted eleven resident species including Smallmouth Bass, Largemouth Bass, White Sucker, Walleye, Trout species (including Brook Trout, Rainbow Trout, and Brown Trout), sunfish (Bluegill and Pumpkinseed), Bullhead (Brown and Yellow bullhead), Crappie (Black and White), Norther Pike, Chain Pickerel, Yellow Perch, Common Carp and ‘other’. The other category was used for any unidentifiable species that were recorded on the camera.

During the study, five of the eleven resident species were observed using the upstream fish ladder at the Project.

189. Fish were observed using the ladder from May 3, 2015 through November 3, 2015. The camera footage was reviewed which allowed the ability to count the number of fish moving upstream or downstream through the ladder, in addition to the timing of when fish moved through the monitoring season. The following table notes the target species, the date of first fish passage, the date of last passage, the date of the peak passage, in addition to when 80 percent of the fish had passed through the ladder (Table 14).

Table 14. Observed fish moving upstream at the Bellows Falls fish ladder in 2015. Net fish is the number observed going up minus the number observed going down. The first date indicates date of fish species or genera moving up, peak date is when maximum number of observations were made, 80% date is the date at which 80% of the fish had passed, and the last date is the last date of observations for the species or genera.

Species/ Genera	Net Passage	First Date	Peak Date	80% Date	Last Date
American Shad	44	5/26	5/28 – 5/30	5/30	6/20
Atlantic Salmon	1	6/08	NA	NA	6/08
Sea Lamprey	970	5/19	5/29 – 6/01	6/01	7/07
American Eel	60	6/21	7/09, 7/21, 7/23, 7/26, 7/28, 7/30, 8/06, 8/11, 8/20, 8/23, 8/29, 9/11, 9/13	9/13	11/1
Bass	-47	5/12	NA	5/25	11/3
White Sucker	7	5/03	NA	5/05	5/26
Walleye	2	5/10	NA	5/14	9/25
Trout	8	5/20	8/2	7/08	9/21
Sunfish	7	5/29	NA	9/23	9/18

190. The number of fish observed moving upstream in the ladder, with the notable exception of sea lamprey, made it difficult to determine if movement varied with operational changes. For example, how the river flow was partitioned through the facility (i.e. fish ladder, attraction water, discharge through the units, spillage) are elements that introduce uncertainty to assessing the effects of operations on ladder performance.

191. In 2015, it was noted that most species movements occurred in the spring, which covered a wide range of river flows. Additionally, the majority of resident species moving either upstream or downstream within the ladder, as indicated by net passage numbers, occurred during the currently prescribed operating period of the fish ladder, which is typically from spring until July 15. Obligate migratory species such as American eel did not reach 80% passage until after the current operation window.

Downstream

192. As described in Finding 43, the Project has downstream fish passage facilities. The target migratory species that need to move through the Project to complete life their cycle include American eel and Sea Lamprey.

193. American eel life cycle requires them to migrate out of freshwater ecosystems to the Sargasso

Sea to spawn. For the eel life stages in the Connecticut River this includes the "silvering phase" during which adults begin to change color pigmentation and increases in eye diameter occur. The timing of metamorphosis and out-migration can vary.

194. The Applicant conducted two studies to provide information on downstream passage of American eel. The first was related to safe timely and effective passage of adult American eel (Study 19) and the second was a desktop study to investigate the migratory cues that trigger the downstream migration of American eel (Study 20).

195. The literature review of examined various potential cues that trigger American eel to migrate. While much of the specificity of triggers were focused on literature from the Connecticut River basin, other basin types were also reviewed to identify commonality among cues.

196. Although there are several of studies related to the out-migration timing of American eel, the anticipated cues used continue to only be generally defined. However, the literature suggest that decreasing water temperatures and increasing streamflow does play a role in cueing the out-migration. To what extent, or if there is a specific value of discharge or temperature, continues to remain unknown and may be location specific.

197. In the assessment of safe timely and effective downstream passage of American eel, the Applicant assessed turbine survival as well as quantifying movement rates, timing, and route selection at the Project.

198. As described in Finding 33, the three turbines at the Project are identical Francis units. For the turbine survival study, 50 eels were released through Unit 2. Prior to releasing fish into the turbine, they were tagged. One type of tag was three to six HI-Z balloon tags that are designed to deploy after passing through the turbine to bring the fish to the water surface for recapture. The number of HI-Z balloon tags used was dependent on the size of the fish. A radiotelemetry tag was also attached to one of the ballon tags. This was used to locate any fish that may not return immediately to the surface. The last tag was a small, numbered Floy tag to identify individuals.

199. In addition to the fish released into the turbine, a control group of ten fish were tagged and released at the Project, but did not pass through the turbine to assess any effect from the tagging process.

200. After passage, live and dead eels were captured and the condition of each was examined for visible injuries or loss of equilibrium. Fish were then held for 48 hours to assess delayed mortality related injuries and to assess shear effects via a necropsy.

201. Both the treatment and control eels had a recapture rate of 100 percent. However, the recapture rate of 97.4 percent for the combined controls from all the Projects, which includes the Wilder and Vernon Projects, was used in the analysis. The estimated immediate survival, defined as 1 hour, was 100 percent. The 48-hour direct survival rate was 98 percent for eels that passed through the turbine. The injury rate was 14 percent with 6 percent of eels examined determined to have sustained injuries that would be considered major. The primary injuries were bruising to the body.

202. Because all three units at the Project are similar, the survival rate through Units 1 and 3 are

thought to be comparable. In addition, the direct survival estimate was higher than the range of predicted survival estimates of 54 to 77 percent from Study 23 at discharges similar to those during the assessment.

203. Additionally, the Applicant conducted a study to examine the timely passage and route selection of American eel through the Project. For this portion of the study, 50 radio tagged eels were released in the Project impoundment, approximately three miles upstream of the dam. Eels were released in five groups of ten distributed throughout the study period.

204. Of the 50 eels released in the impoundment, all but one moved downstream and were detected by receivers at Bellows Falls Project. Of the 49 eels detected at the Project, 47 moved downstream through the Project while two individuals were determined to have entered the power canal but did not move further downstream. The passage routes selected by eels moving downstream of the Project from this release was 78.7 percent passing via Units 1 – 3, 12.8 percent passed via the trash/ice sluice, and 8.5 percent passed via the spillway into the bypass reach.

205. An additional 20 radio tagged eels were released into the Bellows Falls power canal during two spill events. All these eels passed downstream with 19 passing through the Units 1 through 3 and one eel passing via the trash/ice sluice.

206. In addition to the eels released in the Bellows Falls impoundment and power canal, 29 radio tagged eels that were released at the Wilder Project impoundment moved downstream of the Bellows Falls Project. Table 15 summarizes the passage route for all eels approaching the Bellows Falls Project from the different release points.

Table 15. Route selection of American eels from different release groups through the Bellows Falls Hydroelectric Project from a study conducted in 2015.

Passage route	Number of fish	% of all individuals passed	% of all those individuals released
Bellows Falls Impoundment Released Eels			
Units 1 – 3	37	78.7%	74%
Trash/Ice sluice	6	12.8%	12%
Dam Spillway	4	8.5%	8%
Total Passed	47	100%	94%
Did not pass	2		4%
Did not approach	1		2%
Total Released	50		100%
Bellows Falls Power Canal Released Eels			
Units 1 – 3	19	95%	95%
Trash/Ice Sluice	1	5%	5%
Dam Spillway	0	0%	0%
Total Passed	20	100%	100%
Did not pass	0		0%
Did not approach	0		0%

Total Released	20		100%
Wilder Impoundment Released Eels			
Units 1 – 3	21	72.4%	42%
Trash/Ice Sluice	6	20.7%	12%
Dam Spillway	2	6.9%	4%
Total Passed	29	100%	58%
Did not pass	0		0%
Did not approach	21		42%
Total Released	50		100%
All Upstream Released Eel			
Units 1 – 3	77	80.2%	64.2%
Trash/Ice Sluice	13	13.5%	10.8%
Dam Spillway	6	6.3%	5%
Total Passed	96	100%	80%
Did not pass	2		1.7%
Did not approach	22		18.3%
Total Released	120		100%

207. In addition to route selection, the estimated time it took for an individual to move past the facility was examine. The telemetry data allowed for estimates of time for each individual to pass and how long an individual spent at any one location. Where data was available, the approach duration, power canal residency time, tailrace residency time, bypass reach residency time, and total time in the Bellow Falls study area was calculated for each individual. The table below is a summary of all American eel passage durations for all groups combined (Table 16).

Table 16. Duration of time for American eel spent passing through various routes at the Bellows Falls Hydroelectric Project in 2015.

Location of Interest	Min (hrs.)	Max (hrs.)	Mean (hrs.)	Median (hrs.)	No.
Approach Duration	0.6	867.2	69.4	16	46
Power Canal Residency	0.1	307.1	13.2	0.2	90
Tailrace Residency	<0.1	1,879.10	63.9	0.1	90
Bypass Reach Residency	13	1,672.90	369.1	50.7	6
Total Project Duration	0.4	1,843.90	106.4	1.4	71
Total Project Duration for group released in canal	0.1	1,967.20	151.8	3.5	20

208. Approach duration was able to be calculated for 46 of the 49 individuals detected at the Bellows Falls Project. Three individuals that were released in the impoundment were not detected at the upstream approach monitoring station and as a result approach duration of those individuals could not be calculated. Of those 46 individuals, the approach duration ranged from approximately 0.6 hours to 867.2 hours with an overall median duration of 16 hours. Approximately half of the radio tagged eels released in the Bellows Falls impoundment were detected at the Project within eight hours following the release.

209. Detection information was available for 70 of the 72 individuals for calculating residency duration in the power canals at the Project, as well as all 20 of the radio tagged eels that were released directly into the power canal. The residency time for power canal ranged from 0.1 hour to 307.1 hours with an overall median of 0.2 hours. The residency time in the power canal was less than three hours for 84 percent of eels that passed the Project (74 of the 88 that passed downstream and had a known power canal residency duration). There was no statistical difference between residency time and eventual passage route.

210. Tailrace residency duration time could be calculated for 90 eel that passed the Project via routes available at the powerhouse. When all release groups of eel are considered, tailrace residency time ranged from <0.1 hour to 1,879.1 hours. The majority of eel, approximately 83 percent, that passed through powerhouse routes were detected within the tailrace for four or fewer hours following passage. Three individuals were detected for at least 46 days after passage and were not detected downstream were likely mortalities.

211. The mean tailrace residency duration did differ significantly between eel passing via the trash/ice sluice and those passing through the units. The mean for eel passing through the sluice was 0.1 hours (n=13), while the mean for eel passing through the units was 74.6 hours (n=77). The longer duration of eel passing through the units was driven by several of individuals that remained stationary in the tailrace for a prolonged period of time following passage which were likely mortalities.

212. There were six radio tagged eels that passed via the spillway into the bypass reach. The bypassed reach residency time for those eels following their initial detection at the upstream end of the bypass ranged from 13.1 hours to 1,672.9 hours (over 69 days). The individual eel with the residency time of over 69 days was still present in the reach at the conclusion of the study and was thought to be a mortality. Excluding this individual, the median residency duration in the bypassed reach was 46.8 hours.

213. Total project residency duration time was calculated using valid detection information that was available for 71 of the 76 eels released into either the Wilder or Bellows Falls impoundment. The total project residency time, which is time from an individual is detected upstream approaching the Project until its final detection downstream. ranged from 0.4 hour to 1,843.9 hours with a median of 1.4 hours. Approximately 83 percent (59 of 71 individuals) of eel that had valid detection information and were released into Wilder or Bellows Falls project impoundment arrived and departed the Bellows Falls study area in less than 24 hours.

214. As part of the relicensing, the Applicant is proposing to install a minimum flow unit at the dam to pass the proposed 300 cfs to the bypass reach. The proposed turbine is a Natal Energy's Restoration Hydro Turbine with a hydraulic capacity of 300 cfs to 345 cfs. While the turbine type is thought to have a high survival rate of American eel passing through the unit, the Applicant is proposing to conduct a post-commissioning evaluation of turbine survival and injury of adult American eel to evaluate survival at the project site. A study plan will be developed in consultation with the state and federal fisheries agencies with the aim for the study to take place during the first downstream passage season following the commissioning of the new unit.

J. Aquatic Habitat

215. The Connecticut River is classified by the State of Vermont as Class B(2) for the aquatic

habitat designated use.

216. Waters classified as Class B(2) for aquatic habitat use shall be managed to achieve and maintain high quality aquatic habitat, characterized by the physical habitat structure, stream processes, and flow characteristics of rivers and streams and the physical character and water level of lakes and ponds necessary to protect and support all life-cycle functions of aquatic biota and wildlife, including overwintering and reproduction requirements. (Standards, Section 29A-306(b)(3)(A)).

217. There are three distinct areas where the Project may affect aquatic habitat: the impounded reach above the dam, the reach of the Connecticut River that is bypassed by the diversion of water to the powerhouse, and the Connecticut River downstream of the powerhouse.

218. The Bellows Falls impoundment extends roughly 26 miles upstream to the Windsor, Vermont area. The gross storage is 26,900 acre-feet with a usable storage of 7,476 acre-feet assuming a 3-foot drawdown. At the normal full pond elevation (291.6 feet msl) the surface area is 2,804 acres.

219. The total length of the reach of the Connecticut River bypassed by the Project is approximately 3,500 feet or 0.7 miles. Overall, the mesohabitat composition of the bypass reach is 73 percent pool habitat, 16 percent run habitat, and 8.5 percent riffle habitat. There is a fish barrier in the bypass reach approximately 0.4 miles downstream of the dam that was constructed in 1996 to prevent fish from gaining access to the upper portion of the of the reach and possibly becoming stranded.

220. Below the Project there is a stretch of riverine habitat until it reaches the backwater from the Vernon impoundment. The reach is approximately six miles in length and comprised of pool, glide, run, riffle, and cascade habitats. The Cold River and the Saxton River are major tributaries that flow into the Connecticut River in this reach.

Flow Needs for the Protection of Aquatic Habitat

221. The Applicant has proposed to operate the Project in an IEO mode for the majority of the time, with constrained discretionary ‘flexibile operations’ that vary by month and season with transition operations to bridge departures from and returns to IEO mode. As part of the relicensing, the Applicant conducted a flow-habitat study in the bypassed reach and riverine reach downstream that employed hydraulic habitat modeling to assess the relationship between aquatic habitat and streamflow for target species and life stages using habitat suitability curves selected in consultation with the Department and other stakeholders.

222. Habitat suitability curves include information on suitability for substrate types, velocities, and depths. The suitability of each variable falls within a range of 0 to 1, 0 being not suitable at all, and 1 being most suitable. Each variable is multiplied at each cell across the transect to obtain an overall suitability score. These values are then summed at each transect and each modeled discharge to determine the amount of suitable habitat.

Bypass Reach

223. The reach of the Connecticut River bypassed by the Project is relatively steep with channel

dimensions that tend to contain flow in the main channel. As a result of the geomorphology of the channel, the depth and velocity tend to increase in the main channel at a faster rate than the wetted width.

224. The management goals and objectives for the bypass reach was to prioritize the protection of the riffle habitat in this reach of the Connecticut River as this is a rare and limited habitat type available in this section of the Connecticut River. Additionally, riffles are the most sensitive habitat type to changes in flow.

225. In consultation with the Department and other stakeholders, the Applicant selected seven transects in the reach to measure the relationship between aquatic habitat and flow for target species and life stages. Five of the transects were located in riffle and run habitats. The other two transects were located in pools.

226. The hydraulic habitat study used a one-dimensional Physical Habitat Simulation Model (PHABSIM). Originally it was anticipated that the Applicant would collect three flows to calibrate the hydraulic model, the higher target flow of 2,500 cfs never stabilized enough to collect quality data that could be used for calibration. Therefore, depth and velocity calibration sets for the transects were only able to be collected for a flow of 286 cfs and 921 cfs.

227. Due to only being able to collect calibration data at two flows, the water surface elevation component of the model was estimated using Manning's equation allowing the roughness to vary with discharge. Additionally, the model was only able to estimate depths and velocities to 2,500 cfs as the maximum, as a hydraulic model can only be extended 2.5 times the highest measured flow.

228. To confirm the validity of the hydraulic model, transect data was reviewed to ensure basic assumptions are met. One key assumption in hydraulic modelling is that flow remains perpendicular to the transect or cross section through all flows that are modeled. The reason is because the cross-sectional ratio of wetted width and depth is used to inform the Manning's n value, also known as the roughness coefficient. This is used in the hydraulic model to help predict the velocities and depths are at the edges of the wetted channel.

229. In reviewing the transects in the Bellows Falls bypass reach, alignment of transect four relative to the stream channel particularly when flow increased appeared to not remain perpendicular to the flow. In review of the data, transect four increased in wetted width relative to the other selected transects at a much faster rate than other transects when modeled. This suggests that the rate of wetted width increase at transect four may be an artifact of the misalignment (Figure 2).

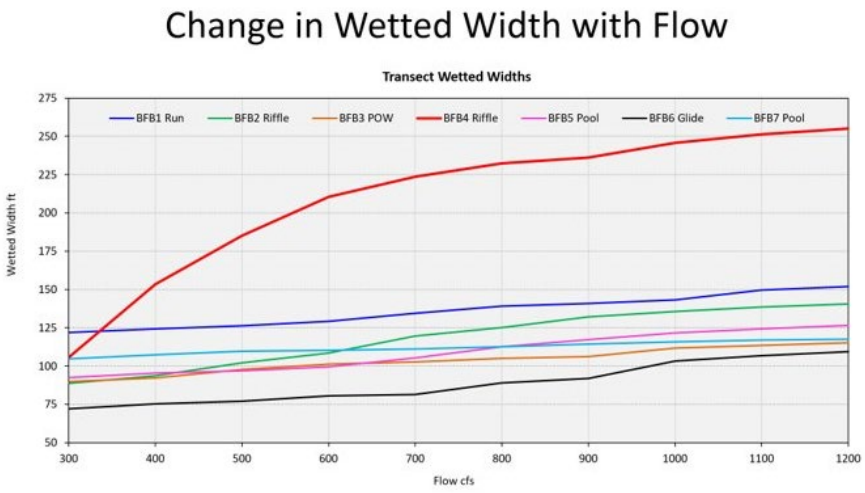

Figure 2. The graph shows the increase in wetted width with increase in flow (cfs) for all the transect measured as part of the Bellows Falls bypass flow habitat study. Transect 4 (red) wetted width increases at a relatively faster rate than the other transects in the study

230. Additionally, the transect placement appeared to run along the margin of the channel rather than up the bank. This suggested that the channel had a wider area of shallow margin habitat than there was due to the misalignment of the transect and was distinctly different from other transects (Figure 3).

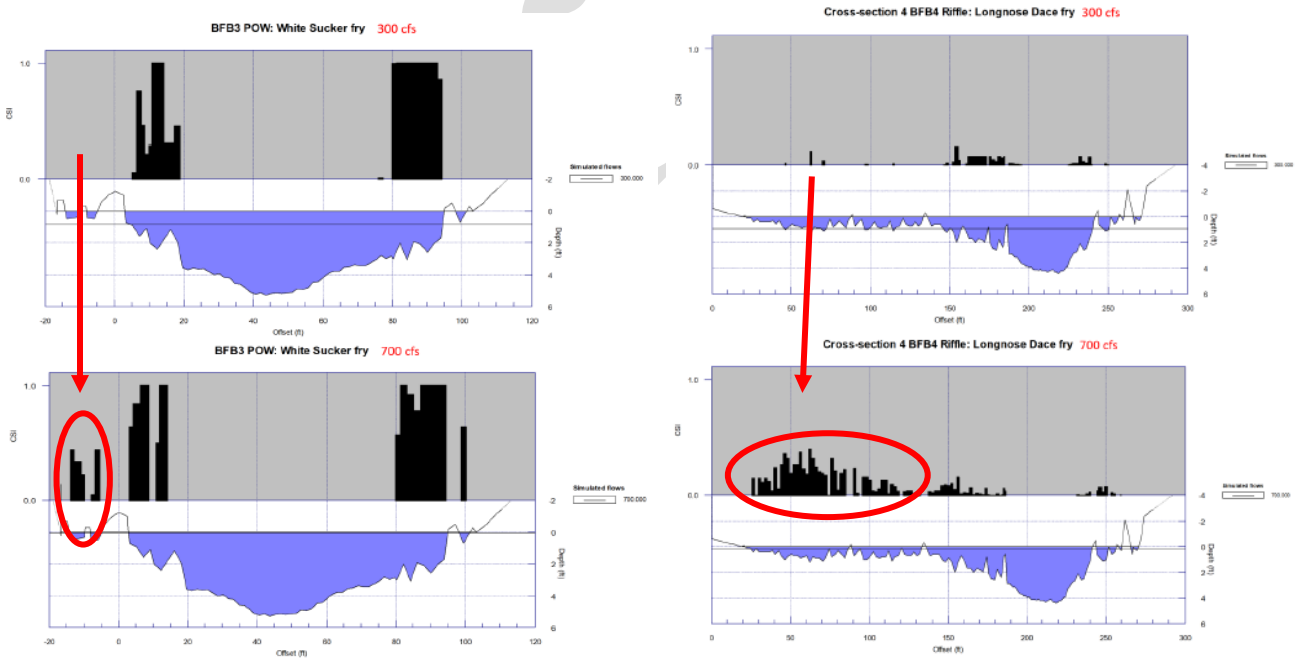

Figure 3. Difference in magnitude and suitability of margin habitat (red circles) at higher flows between transect 3 (left graph) and transect 4 (right graph) for the Bellows Falls bypass habitat-flow study.

231. Based on Department review of the data, it appears that transect four violates the basic assumption in hydraulic modeling that flow remain perpendicular to the cross section. As the

analysis to calculate the amount of suitable habitat relies on the hydraulic model outputs, the issue with transect four needed to be addressed.

232. After evaluating several of alternatives that assigned different weights to transects or mesohabitat type, the Department concluded that the appropriate remedy was to omit transect four from the analysis due to the violation of the modeling requirements. While removing the transect reduced the riffle transects included in the study, it did not reduce the critical habitat under consideration within the modeled bypass.

233. The stakeholders originally requested that all species and life stages included in the habitat-flow study downstream of the Project be included in the bypass reach study. These included Walleye fry, Walleye juveniles, Walleye adult, Walleye spawning, Fallfish fry, Fallfish juveniles, Fallfish adult, Fallfish spawning, White Sucker fry, White Sucker adult/juvenile, White Sucker spawning, Longnose Dace fry, Longnose Dace juvenile, Longnose Dace adult, Tessellated Darter, Sea Lamprey, macroinvertebrates, Smallmouth Bass fry, Smallmouth Bass juvenile, Smallmouth Bass adult, and Smallmouth Bass spawning.

234. However, based on the overall management objective for the bypass reach of river to prioritize the protection of riffle habitat, the Department went through each species and life stage to evaluate habitat preferences for each. To accomplish this task a review of the literature, habitat suitability curves, and if available, how the habitat suitability curve was developed, were reviewed to select the species and life stages that were riffle dependent to include in the optimization model.

235. Additionally, the substrate data from the bypass reach was evaluated to determine if it was suitable for spawning. Review of the habitat suitability curves indicated that the fish species need sand, gravel or small cobble size substrate to spawn. The data collected in the bypass as part of the habitat-flow study indicated that substrate in the riffles was mostly bedrock and boulders with limited pockets of finer substrate that would support spawning. This composition of substrate is likely due to the higher velocity flows that occur in the reach during periods of high flow when the flow of the river is over the capacity of the Project (> 11,400 cfs). Given the lack of suitable substrate, spawning and fry life stages were not included in the optimization model.

236. The final list of species and life stages included in the model for the bypass reach was Fallfish adult, White Sucker juvenile and adult, Longnose Dace juvenile and adult, Tessellated Darter, and macroinvertebrates.

237. The aquatic habitat for the species and life stages modeled did not share the same patterns as flow increases through the bypass reach. Aquatic habitat for fallfish adults and white sucker juveniles and adults started at greater than 80 percent of their maximum available habitat at the lowest flow of 100 cfs. Suitable habitat then decreased with increasing flow before increasing again at much higher flows, both reaching greater than 80 percent of the maximum available habitat again at approximately 1,200 cfs for fallfish adults and 1,600 cfs for white sucker juveniles and adults.

238. The relationship between macroinvertebrate habitat and flow created a bell shaped curve with a flow 250 cfs providing greater than 80 percent of the maximum available habitat. Available habitat continues to increase with increasing flow until the maximum available habitat occurs

between a flow of 475 cfs and 525 cfs. Habitat then decreases, falling below 80 percent of the maximum available habitat at 1,200 cfs and continues to decrease to until the maximum modeled flow of 2,500 cfs is reached.

239. Longnose Dace juvenile, Longnose Dace adult, and Tessellated Darter adult all have more available habitat at the lowest flows and habitat decreases with increasing flows. Longnose Dace juvenile fall below 80 percent of the maximum available habitat at a flow of 200 cfs, and generally, continues to decline with increasing flows. Longnose Dace adult fall below 80 percent of the maximum available habitat at flows of 225 cfs and continue to decrease with increasing flow to the maximum modeled flow of 2,500 cfs.

240. There was no single flow that provided 80 percent of the maximum habitat observed for all species. A flow of 200 cfs provides the maximum amount of habitat for the most limiting species, however not all species have greater than 80 percent of their individual maximum available habitat. There is a narrow range of flows from 150 cfs to 325 cfs that provides 80 percent of the maximum observed habitat for the most limiting species (Figure 4).

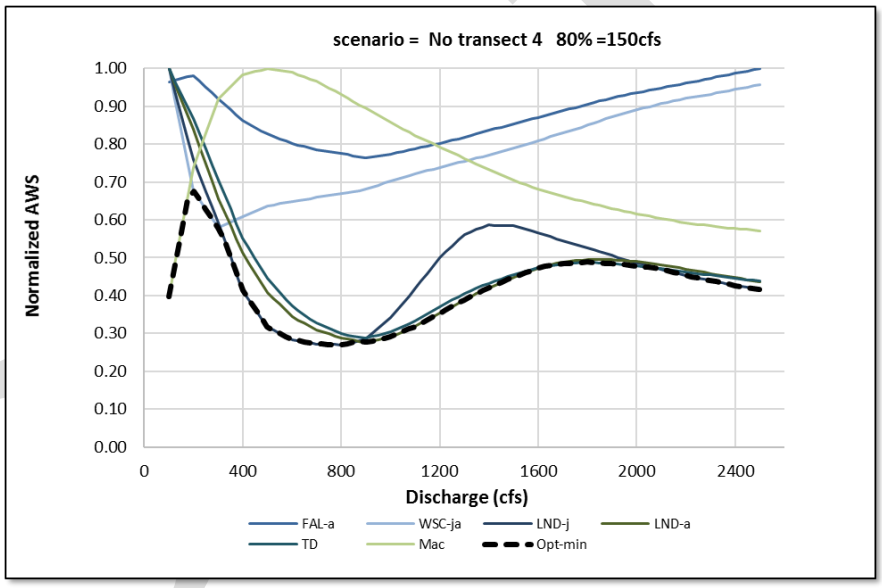

Figure 4. The relationship between flow and habitat (area weighted suitability, AWS) for target species and lifestages for the Bellows Falls bypass reach of the Connecticut River below the Bellows Falls Hydroelectric Project with transect four omitted from the analysis. Species included are fallfish adult (FAL-a), white sucker juveniles and adults (WSC-ja), longnose dace juveniles (LND-j), longnose dace adults (LND-a), tessellated darter (TD), and macroinvertebrates (Mac). The dash line is the optimization minimum.

241. The Applicant has proposed to pass a conservation flow of 300 cfs to the Bellows Falls bypass reach to protect aquatic habitat within the reach.

Downstream Flows

242. The Applicant has proposed to operate the Project in an IEO mode for the majority of the time with flexible operations that vary by season. As part of the relicensing, the Applicant conducted a habitat flow study (Study 9). The study utilized a hydraulic habitat approach to model the relationship of flow to aquatic habitat for target species and life stages.

243. There were four mesohabitat types identified in the riverine reach below the Project to the upper extent of the Vernon impoundment. The mesohabitats identified included pool (shallow and deep), glide, run, and riffle. The Applicant selected transects in consultation with the Department and other stakeholders in the field.

244. A total of 19 transects were selected in the approximately six-mile riverine reach below the Project. Six of the transects were located in pool habitat, seven in glide habitat, four in run habitat, and two in riffle habitat. Each transect was then segmented into sections perpendicular to river flow. In each section, substrate data was collected under low flows. If waters were too deep to identify substrate, then an underwater camera was used. Substrate was coded as detritus/organic, mud/clay, silt, sand, gravel, cobble, boulder, or bedrock.

245. To calibrate the model, depth and velocities were collected at three flows using an ADCP (acoustic doppler current profiler) which was moved back and forth across the river multiple times. The three targeted flows range from low to high within the hydraulic capacity of the Project were 1,300 – 2,000 cfs, 4,500 – 7,500 cfs, and 9,000 – 11,000 cfs. The flows were used to develop a stage-discharge relationships at each individual transect.

246. Each transect was then analyzed to evaluate the relationship between aquatic habitat and streamflow for a series of target species and life stages. The target species and life stages included American shad (juvenile, adult, spawning), Walleye (fry, juvenile, adult, spawning), Fallfish (fry, juvenile, adult, and spawning), White Sucker (fry, juvenile/adult, spawning), Longnose Dace (juvenile, adult, and young of year), Tessellated Darter adult, Sea Lamprey spawning, Smallmouth Bass (young of year, juvenile, adult, and spawning), benthic macroinvertebrates, Rainbow Trout adults, dwarf wedgemussels, and co-occurring mussels.

247. In addition to the specific species and life stages, the Applicant included suitability for various mesohabitat types including shallow-fast, shallow-slow, deep-fast, and deep-slow. This would offer an opportunity to review available habitat in a broader context in addition to species specific information.

248. Habitat suitability curves for each species were chosen in consultation with the Applicant, their consultants, and relevant agencies. Two habitat suitability curves, co-occurring mussels, and dwarfwedge mussels were developed as part of a delphi process and included additional variables of shear stress, bed shear stress, and benthic water velocity.[12]

249. In addition to determining the available habitat at any single discharge, available habitat can also be determined using either a dual flow (immobile species) or two flow (mobile species) analysis. In a dual flow analysis, the amount of habitat at two different flows are estimated on a cell-by-cell basis across each transect. Any cell that contains adequate available habitat under

[12] The delphi process is a discussion between a group of experts in an effort to reach consensus on a topic. For the delphi based HSC curve the development, the process was as follows (1) a group of experts was identified; (2) the objectives and procedures of the Delphi exercise were explained to each expert; (3) the experts agree to participate as panelists; (4) each panelist gave their opinion or estimate on the inquiry; (5) the results, including rationale given by each panelist, were summarized and fed back to each panelist, ending the first round; (6) panelists answered the inquiry again, in light of the information generated by the collective responses from round 1; (7) the process was repeated until a consensus or acceptable level of agreement was reached; (8) the exercise is terminated and the procedures and results are documented, including all rationale for agreement or disagreement."

both flows is counted. This accounts for a species and life stage of interest who is considered immobile and cannot readily move to a location with adequate habitat.

250. A two-flow analysis considers the amount of available habitat across a transect at two different flows. The flow that contains the least amount of habitat is considered to be available under the scenario. This methodology accounts for mobile species who could be expected to move from one location to another for adequate habitat.

251. The results of the study indicate that there is a wide range of flows over which habitat for each species and life stages of interest are optimized in the Bellows Falls riverine reach, rather than a flow that accommodates all species. This is understandable given the wide variety of species evaluated and the variances in habitat preferences. However, some general conclusions can be drawn.

252. Aquatic habitat for target species and life stages tended to be most affected with the increase in magnitude between the two flows. For example, the dual flow analysis for the immobile white sucker fry indicated that when flow from Project's minimum capacity increased to its maximum capacity, the amount of suitable habitat decreased by 81percent. However, when the magnitude of the change was decreased between two flows the percentage of habitat lost decreased. This trend was similar for most immobile species, although the degree that habitat was affected varied.

253. The two flow analysis for mobile species and life stages indicated a similar trend as the dual flow analysis for most target species and life stages. For example, suitable habitat for fallfish adults decreased by 62 percent from the minimum flow to the maximum generation flow for the Project. However, the percentage differences between available suitable habitat decreased by less when the difference between the two flows decreased.

254. In addition to the energetic cost associated with needing to relocate to suitable habitat in response to daily peaking, there is a concern that rapid changes in flow may result in fish becoming stranded or may increase the likelihood of predation. The likelihood of this occurrence depends on the species, the swimming ability, and preferred habitat. For example, a fish species who prefers shallower depths and have weak swimming capabilities are more likely to become stranded than those who prefer pool type habitats.

255. Immobile life stages such as spawning, incubation, and fry tend to be the most sensitive to changes in flow depending on the species. In general, these life stages typically have a more limited range of suitable depths, velocities and substrate types.

256. The instream flow habitat study results indicate that when evaluating a single optimized flow at a seasonal level there is a wide range of flows over which habitat is optimized for a given species and lifestage. However, when considering the magnitude of change between two flows, the smaller the change, the greater the amount of suitable habitat remains.

Water Level Fluctuation in the Impoundment

257. The Applicant has proposed to operate the Project in an IEO mode, maintaining a target water elevation, plus or minus six inches at the dam. Operating in IEO the Project will not operate out of storage. This will result in minimal water level fluctuations within the impoundment.

258. The Applicant proposes restricted, discretionary flexible operations with the frequency of these operations varying seasonally. During flexible operations, the Project will operate out of storage which will result in water level fluctuation in the impoundment which could affect immobile species such as dwarf wedgemussels (See Rare, Threatened, and Endangered Species section), the spawning activity of fishes (See Protection and Support of Life Cycle Functions) and potentially result in erosion (See Stream Processes and Physical Habitat Structure).

259. The Project will employ transition operations between IEO and flexible operations, which will limit the rate of drawdown during flexible operations and the time that an area of the impoundment may be dewatered. Specifically, the employment of an up ramping rate and the requirement to refill within 48-hours after flexible operations have ended.

260. In addition to flexible operations, unplanned maintenance activities are not seasonally planned as they are dependent on when repairs are needed. The timing and duration of a drawdown can have different effects on habitat availability within the impoundment.

Stream Processes and Physical Habitat Structure

261. Stream processes are defined as the hydrologic, bed-load sediment, and large woody debris regimes of a particular stream reach and is a term used to describe stream channel hydraulics, or the erosion, deposition, sorting, and distribution of instream materials by the power of flowing water. Stream processes work toward an equilibrium condition, are governed by flow characteristics, stream morphology, channel roughness, and floodplain connectivity and, in part, determine physical habitat structure and aquatic habitat quality (Standards Section 29A-102 (43)).

262. Physical habitat structure is defined as the diverse combination and complexity of instream forms created within substrate and woody debris on and within the bed and banks of the channel by stream processes and flow characteristics. Physical habitat structure, in part, determines aquatic habitat quality at the stream reach and stream network scales by providing for all life cycle functions, which includes the full set of forms necessary for the provision of and access to cover, overwintering, and temperature refuge and the substrates necessary for feeding and reproduction of aquatic biota and wildlife (Standards, Section 29A-102 (34)).

263. Erosion is a natural process that occurs in waterbodies at the interface of water and land. There are sevaral of forces acting on the substrates, channels, and corridors of rivers. There are many processes that can contribute to erosion within rivers, some include hydraulics from river flows, freeze thaw cycles, and abrasion which grinds away portions of stream channels. There is some erosion that can also be exacerbated by anthropogenic causes. Bank erosion occurs when the various forces of erosion are stronger than the strength of the bank material. River channels move as part of this natural erosional processe to maintain an equilibrium condition. This process can be hindered by manmade structures such as dams, in addition, to other management practices that were historically used to manage the river system such as straightening and armoring.

264. The Connecticut River was historically straightened and armored for economic related activities such as log drives and armoring of the railroad corridor for protection under high flow conditions. These activities can exacerbate erosional processes typically during high flows or flood flows, and at constriction points in the river.

265. As part of the relicensing of the Project, the Applicant conducted studies on erosion (Studies 1 – 3) along reaches of river affected by Project operations over the course of 2 years. The studies collected field data at several different transects over the 2-year study period, as well as, examining historical photos to estimate historical erosion and estimate the rate.

266. The analysis of historic photos of the river collected photos from various sources from as early as 1940 through 2010 (Study 1). While the available data set varied depending on the river reach, a rate of movement per year was able to be estimated. Additionally, it is important to note that the analysis is imperfect due to the lack of data associated with photos and lack of global positioning data, however alignment of the photos at the location and using additional measurement and best professional judgment were needed for the estimates.

267. The initial analysis of historic photos (Study 1) focused on 11 locations where the river channel had changed significantly enough that the changes could be considered real and not a product of error in the georeferencing process. The trend observed at these locations when analyzing the photos through time was that rate of change in the river channel had decreased through time.

268. The Applicant conducted an analysis of historic aerial photos for the entire reach of river affected by Project operations. The analysis was completed by measuring the amount of change between each available photo year for every 0.5 mile of river. Photos were evaluated to determine if there were issues with the georeferencing process which would make the data inaccurate.

269. Due to the lack of photos from 1940 series, these were not included in the Bellows Falls analysis. Analysis of the remaining historical photo of the Bellows Falls impoundment suggest that erosion rate between 1953 to 1975 were on average significantly higher than they was between 1975 to 2010, decreasing by an estimated 50 percent or more at many locations.

270. Spatially, the rate of erosion in the lower Bellows Falls impoundment in general was greater through time than in the upper impoundment. Field evidence such as sand bars in the channel, scroll bars on the low floodplain, and measurement of the most significant bank retreat of the monitoring location, corroborated the findings that significant change had occurred. It is postulated that the increase in the rate of erosion in the lower impoundment may be due to the backwatering effect upstream of the Williams River confluence that could enhance the erosion process.

271. In contrast to the significant changes in the impoundment, the riverine reach below the Project showed relatively little change in bank position since the aerial photographs collected in 1950/55.

272. In addition to the evaluation of historic aerial photos, the Applicant conducted erosion monitoring at six locations in the reaches affected by the Project over a two-year period. Four of the locations were located in the impoundment and two were located downstream of the Project in the riverine reach. Each site was monitored on eight occasions during the study. At each visit a survey along a single transect of the selected bank was measured, photographs of the bank from multiple locations were taken, as well as water level monitoring at 15-minute interval during the study. Additionally, the sediment of the bank was characterized and a one-time survey across the entire channel was completed.

273. Over the course of the study within the impoundment three of the four locations were actively eroding while the one location was categorized as healed erosion. Erosion at these sites primarily occurred between the late fall monitoring conducted in November 2013 and the monitoring in May 2014 and occurred presumably during the spring freshet. The maximum bank recession was 7.5 feet at the impoundment monitoring site in Charlestown, New Hampshire.

274. Within the riverine reach, erosion was documented at one of the two locations. The site with documented erosion was categorized as vegetated eroding with most of the erosion occurring at the toe of the bank throughout the monitoring period.

275. The Applicant examined water surface elevation data for changes during normal operations relative to the height of erosion along the banks. This would be an example of potential notching, where material is removed from the bank closer to the water surface and may over time cause large amounts of material to be removed from the bank.

276. At the first site located within the upper impoundment, a planar slip failure at the top of the bank resulted in 4.5-foot retreat during the study. The sediment moved down the slope and resulted in aggradation of approximately two feet along the bank toe. The top of bank where the original erosion occurred was approximately 35 feet higher than the median surface elevation fluctuation from Project operations.

277. At the second site near Jarvis Island in the impoundment, a large block of material was removed from the mid-bank with some of the material depositing at the bank toe. However, much of the material had been removed by the end of the study and notching at the toe of the bank was occurring near the median surface water elevation fluctuation from Project operations under no spill conditions.

278. The third site within the impoundment near Charlestown, New Hampshire had the largest observed bank retreat during the study of 7.5 feet resulting from a planar slip of a large block at the top of the bank. The large block disintegrated and was removed during the remainder of the study period. Notching at the toe of the bank was present at the end of the study period near the median surface water elevation fluctuations under no spill conditions.

279. The fourth site located within the impoundment was in North Walpole, New Hampshire, a short distance upstream from the dam. During the study period, no erosion or changes in the bank profile were observed. The high steep bank was covered by thick saplings and immature trees, however, there was some evidence that suggested the bank was once actively eroding.

280. The first riverine site monitored during the study was located a short distance downstream of the facility in Walpole, New Hampshire. There were no observed changes along the upper bank or along the toe of the bank during the study period.

281. At the second riverine site monitored, a large volume of fine sand deposited on the mid-bank bench along with large course woody debris. Planar slips in the lower bank occurred twice during the study period removing from the front of the mid-bench. Overall, the toe of the bank retreated 2.9 feet during the study period.

282. There is recognition that the magnitude of impoundment water surface elevation change

depends on the location within the impoundment related to Project operations. This is in part due to the hydraulic controls located within the impoundment shorelines and the inflow from both upstream and tributaries to the impoundment. As part of the relicensing, the Applicant as developed water surface elevation nodal data from the top of the impoundment to the Bellows Falls Dam. This allows the Applicant for representative years and months to model the minimum and maximum daily average elevation changes throughout the impoundment (Findings 57 - 59).

283. There are a total of 197 different nodes (locations where water surface elevation is modeled) between the Bellows Falls dam and the top of the impoundment. These are located at relatively equal segments. A series of nodal data from the dam area to the most upstream of the impoundment can be analyzed to assess changes in water surface elevation using the model provided by the Applicant.

284. In the tables below, eight nodes roughly evenly spaced between the Bellows Falls dam and the upper impoundment are presented to be representative of what is occurring within the Bellows Falls impoundment. Due to the intensity of the model, the years and months are representative of both seasonal operational changes and a range of hydrologic conditions that would be anticipated.

285. Table 17 is the modeled results of the difference between average minimum water surface elevation per month and the average maximum daily surface water elevation for proposed operations. Table 18 is the modeled results of the difference between average minimum water surface elevation in each month and the average maximum daily surface water elevation in an inflow equals outflow mode, or as if the Project were strictly passing any inflow downstream.

Table 17. Modeled results of the difference between average minimum water surface elevation per month and the average maximum daily surface water elevation for proposed operations. Years represent different types of hydrological years from wet to dry. The months (February (Feb), June, August (Aug), and November (Nov)) are representative of different seasons and the number of flexible hours.

Year	Month	Node 515	Node 540	Node 565	Node 590	Node 615	Node 640	Node 665	Node 690
2009	Feb	0.36	0.39	0.39	0.44	0.50	0.50	1.06	1.67
	June	0.10	0.13	0.18	0.27	0.45	0.66	0.94	1.27
	Aug	0.08	0.14	0.19	0.28	0.45	0.66	0.92	1.24
	Nov	0.05	0.10	0.17	0.26	0.45	0.70	0.97	1.38
2015	Feb	0.46	0.46	0.43	0.46	0.41	0.51	0.65	1.16
	June	0.05	0.14	0.27	0.44	0.75	1.00	1.29	1.48
	Aug	0.17	0.17	0.19	0.22	0.27	0.36	0.51	0.98
	Nov	0.34	0.34	0.34	0.37	0.39	0.49	0.67	1.11
2016	Feb	0.24	0.36	0.48	0.67	0.94	1.19	1.52	1.97
	June	0.10	0.11	0.13	0.16	0.22	0.30	0.42	0.67

	Aug	0.15	0.16	0.17	0.19	0.23	0.29	0.41	0.82
	Nov	0.36	0.37	0.36	0.38	0.40	0.51	0.67	1.25
2017	Feb	0.40	0.46	0.50	0.60	0.69	0.90	1.24	1.94
	June	0.08	0.13	0.19	0.28	0.49	0.71	0.96	1.19
	Aug	0.22	0.22	0.22	0.24	0.24	0.26	0.35	0.76
	Nov	0.23	0.28	0.31	0.39	0.49	0.69	0.96	1.40

Table 18. Modeled results of the difference between average minimum water surface elevation per month and the average maximum daily surface water elevation for inflow equals outflow, or as if the Project was only passing flows that entered the impoundment. Years represent different types of hydrological years from wet to dry. The months (February (Feb), June, August (Aug), and November (Nov)) are representative of different seasons and the number of flexible hours.

Year	Month	Node 515	Node 540	Node 565	Node 590	Node 615	Node 640	Node 665	Node 690
2009	Feb	0.0	0.0	0.02	0.04	0.10	0.17	0.27	0.45
	June	0.0	0.03	0.08	0.17	0.34	0.56	0.82	1.16
	Aug	0.0	0.06	0.12	0.21	0.42	0.63	0.90	1.22
	Nov	0.0	0.05	0.12	0.21	0.40	0.61	0.82	1.06
2015	Feb	0.0	0.0	0.02	0.02	0.10	0.12	0.16	0.37
	June	0.0	0.09	0.23	0.42	0.75	1.02	1.32	1.58
	Aug	0.0	0.0	0.03	0.07	0.14	0.23	0.38	0.82
	Nov	0.0	0.01	0.03	0.05	0.11	0.19	0.28	0.45
2016	Feb	0.0	0.12	0.25	0.43	0.71	0.93	1.21	1.51
	June	0.0	0.01	0.04	0.07	0.16	0.26	0.38	0.68
	Aug	0.0	0.0	0.02	0.04	0.10	0.15	0.25	0.57
	Nov	0.0	0.0	0.02	0.03	0.08	0.15	0.22	0.41
2017	Feb	0.0	0.05	0.13	0.21	0.35	0.48	0.63	0.89
	June	0.0	0.05	0.10	0.19	0.39	0.60	0.84	1.07
	Aug	0.0	0.0	0.01	0.04	0.07	0.10	0.17	0.44
	Nov	0.0	0.04	0.09	0.14	0.27	0.38	0.51	0.66

286. There are number of similarities between the difference in the daily average of the maximum and minimum surface water elevation within the impoundment under the proposed IEO with

flexible operations compared to strict IEO operations. These include greater changes in surface water elevations in the upper reaches of the impoundment (higher numbered nodes), as well as the range of elevation modeled under the two scenarios. For the proposed operations the difference in daily minimum and maximum surface water elevations ranged from 0.05 to 1.97 feet while under the IEO mode the range was 0.0 to 1.58 feet.

Protection and Support of Life Cycle Functions

287. Water level fluctuations at times throughout the year can affect spawning fish, their eggs, and fry, and can therefore interfere with reproduction. This is particularly true for nearshore habitat, either in the impoundment or riverine reach that may become dewatered with fluctuating flows and water levels.

288. The Applicant conducted a spawning study as part of the relicensing effort. The study involved observing various nesting sites for species of interest, both backwater spawners and tributary spawners, in the early-spring and late spring. It also included an analysis of the effects of fluctuating impoundment water levels and downstream flows associated with current operations.

289. Within the impoundment, study sites focused on areas where fish were likely to spawn, which excluded steep banks and silty or muddy substrates. Sites were also selected based on where observations were likely to occur, therefore excluding hazardous working conditions, and depths less than five to six feet deep.

290. Three backwater sites were selected within the Bellows Falls impoundment and five sites were selected at the confluence of tributaries and the mainstem. In addition, Jarvis Island within the impoundment was monitored as part of the study. The backwater sites were distributed between the upper, mid, and lower impoundment with one in each third. The five sites selected at the confluences of tributaries and the mainstem ranged in stream order of three to six and were distributed throughout the length of the impoundment to the extent feasible. Sites were selected in part based on known spawning locations from angler or Agency reports.

291. Within the riverine reach, site selection focused on where fish were likely to spawn, which excluded areas where velocities would be too slow for Walleye or Suckers (non-riffles) and areas where velocities were too fast for Smallmouth Bass spawning. Additional locations were omitted due to hazardous working conditions, and depths greater than 10 feet where observations would be difficult and would likely not be impacted by Project operations.

292. Three sites were selected at riffles and three sites were selected at islands in the Bellows Falls riverine segment. These were distributed among the length of the reach to the extent possible. Sites were again selected in part based on known spawning locations from angler, or Agency reports.

293. Numerous metrics were collected within the vicinity of each study site. These included water levels via data loggers set to record data every 15 minutes, as well as water temperature, specific conductivity, pH, dissolved oxygen, and turbidity were collected each time a study site was visited.

294. Various methodologies were deployed to observe nest sites depending on the study location.

Egg blocks were deployed to detect spawning of white sucker and walleye at applicable sites. Visual surveys were conducted at backwater sites using two biologists either wading or closely observing study sites and identifying egg masses or adults attending nests in the case of smallmouth bass. In backwater areas, individual fish were captured using minnow traps, angling, and net sweeps then assessed for ripeness to verify successful spawning and visual surveys like those used at backwater sites were also conducted. Snorkeling was employed at tributary mouths and island sampling sites. At all observed nest sites, depth information was collected, and the species of interest was identified to the extent possible.

295. Two methods were used to determine project effects on observed spawning sites. The first was to compare 2015 spawning observations to water surface elevation changes in 2015. The second was to compare the 2015 spawning observations to five different water years using the operations model developed in study 5.

296. Analyzing if a spawning site had been considered dewatered was dependent on the fish species in question. For yellow perch, it was assumed that if the water surface elevation fell below the elevation of the egg mass, it was dewatered. For nest guarding species such as smallmouth bass and sunfish, a minimum depth over the nest was required to avoid impacts. These thresholds were based on habitat suitability curves for various species. It was assumed that if depths were less than 0.5 feet, sunfish species would abandon a nest, and if depths were less than one foot, Smallmouth Bass would abandon their nests. Similarly, it was assumed that fallfish mounds were dewatered, if there was less than 0.5 feet of water above the base of the nest.

297. In addition to analyzing if a nest site was dewatered, the Applicant also considered the duration of egg and fry incubation to assess impacts to spawning. It was assumed that when the nest was first observed that date was day one of egg incubation or fry development. Multiple methodologies were used to estimate the incubation period including degree days or days since observation, which varied according to species and life histories.

298. Within the Bellows Falls impoundment and riverine sites, no white sucker eggs were found on the egg blocks. However, a school of suckers was observed staging at the mouth of the Cold River in the riverine section below the Project in early May. Additionally, a single Walleye egg was collected on egg blocks in the Cold River on May 4. Walleye eggs were not collected at any other site in the Bellows Falls Project area.

299. Northern pike and chain pickerel were not observed at any of the spawning sites, despite extensive effort in searching. Angling encountered the occasional individual that had recently spawned or would be spawning imminently.

300. Within the Bellows Falls impoundment backwater areas sampled, numerous Yellow Perch egg masses, sunfish nest (BBluegill, Pumpkin Seed, and unknown species), along with a few largemouth bass nest locations were found totaling 561, 53, and 2, respectively.

301. Of the Bellows Falls impoundment backwater sites, the percentage of Yellow Perch egg masses that were vulnerable to dewatering ranged from 1 percent to 99 percent with an average of 58 percent in 2015. It should be noted the assumption that the day of first observation constituted the start of the incubation period.

302. Within the Project backwater sites, the two Largemouth Bass nests were not considered to be

dewatered by project operations. The water surface elevation recorded at the site indicated that the 1.5 feet of water remained over the nest throughout the period of observation.

303. Of the observed sunfish nest observed in the Bellows Falls backwater site the percentage vulnerable to being dewatered or abandoned ranged from 10 percent to 29 percent with an average of 19 percent in 2015. This assumed an incubation time of five days from the date the nest was observed, although hatch typically occurs in about three days with typical water temperatures during the spawning period. Additionally, it was also assumed that the continued presence of the adult sunfish was necessary for reproductive success.

304. For late spring spawning species, a total of 19 Fallfish nests were located in the impoundment near tributaries and around islands. No nests was determined to be vulnerable to dewatering in 2015.

305. For Smallmouth Bass, a total of 28 nests were found in the Bellows Falls study area with 15 being located around islands and 13 being found near the confluence of tributaries with the Connecticut River in the impounded reach. Of the 13 nests located near the tributaries, one was determined to be vulnerable to dewatering or abandonment in 2015. The 15 nests found near islands in the riverine section below the Project, it was determined that four were vulnerable to dewatering or abandonment in 2015.

306. Using the data spawning locations collected during the 2015 study, the Applicant determined the maximum, minimum, and median heights of each spawning nest for each target species. This information was paired with the dates when spawning and nest incubation were observed. The fish nest locations were then compared to five different hydrologic years, spanning a range of hydrologic conditions from dry to wet. Table 19 provides an estimate of the average number of days the water surface elevation would be expected to fall below the height of nests or spawning areas.

Table 19. Estimates of the average number of days the water surface elevation would be expected to fall below the height of nests or affect spawning sites for various water years representing the driest to wettest conditions. The values represent the average number of days as a % days below min (Precent of days below minimum elevation of nest), % days below median (percent of days below median height of nest), and % days below max (percent of days below the maximum elevation of nests). The locations are all from the Bellows Project area and include BW (back waters), Island type areas, and Tribs (tributaries). Each value varies depending on the species of interest.

		Species	Yellow Perch	Sunfish	Fallfish		Smallmouth Bass	
		Reach/habitat types	Bellows Falls BW	Bellows Falls BW	Bellows Falls Tribs	Bellows Falls Islands	Bellows Falls Tribs	Bellows Falls Islands
1992	**Driest year**	% days below min	0%	10%	0%	0%	4%	5%
		% days below median	0%	22%	0%	0%	7%	34%
		% days below max	4%	47%	5%	0%	36%	46%
1989		% days below min	0%	8%	0%	0%	3%	4%
		% days below median	4%	17%	0%	0%	6%	22%

		% days below max	13%	35%	0%	0%	25%	29%
1994	**Average Year**	% days below min	0%	0%	0%	0%	0%	0%
		% days below median	5%	2%	0%	0%	0%	1%
		% days below max	15%	12%	2%	0%	11%	6%
2007		% days below min	0%	0%	0%	0%	0%	0%
		% days below median	3%	23%	0%	0%	6%	29%
		% days below max	8%	42%	3%	0%	29%	34%
1990	**Wettest year**	% days below min	0%	6%	0%	0%	2%	4%
		% days below median	0%	14%	0%	0%	5%	15%
		% days below max	0%	31%	0%	0%	20%	25%

307. Spawning year 2015 was used to estimate the location and number of spawning areas within the Project area. It is anticipated that various fish species will spawn where appropriate conditions occur, which may change as hydrologic conditions differ from year to year. As noted above, while many visual surveys took place, the likelihood of observing spawning areas lower in the water column was limited due to turbidity. Therefore, there may have been additional spawning areas not observed.

Sea Lamprey Spawning

308. The Applicant conducted a spawning study specific to sea lamprey (Study 16). The study involved first identifying suitable spawning locations within the Bellows Falls impoundment and the riverine reach downstream of the Project. Within the Project affected area, there were three sites identified in the riverine reach downstream and six sites within the impoundment that contained suitable habitat.

309. In addition to locating areas with suitable habitat for evaluation, migrating sea lamprey were tagged with radio transmitters in order to determine specific spawning habitat locations. Following the standard methodology for tag implantation and after a period of time which allowed sea lamprey to recover, fish were released into the Bellows Falls and Vernon impoundments approximately 1.25 miles above the dams.

310. Of the 20 fish that were released upstream of Vernon dam, one was never relocated, eight moved upstream to the Bellows Falls riverine reach, one moved into the Bellows Falls impoundment, while the others did not move to the waters affected by the Project.

311. Of the 20 fish that were released upstream of Bellows Falls, one was never relocated, one moved back into the Bellows Falls riverine reach, and 10 remained in the Bellows Falls impoundment, while others moved out of the Project affected area.

312. Relocated lamprey were used to confirm spawning activity and site locations, or change the

pre-selected spawning habitat locations.

313. The results of the lamprey tagging indicated that lamprey migrate long distances with some being observed moving up into a tributary, returning to the Connecticut River mainstem, then migrating into another tributary. Additionally, multiple fish were observed at multiple spawning survey locations. This could indicate simply circumstantial observations as individuals were in the vicinity of suitable habitat.

314. Two spawning survey locations within the Bellows Falls impoundment did not have verified spawning activity, through either the radio telemetry, or visual observations during the spring or later in the year when sites were visited again under low water conditions. It was observed at some sites that there were high concentrations of spawning activity including the Black River in the Bellows Falls impoundment and the bar at the confluence of Cobb Brook and the Connecticut River in the Bellows Falls riverine reach.

315. Spawning locations and the elevation where nests were observed were then compared to five different water years using the operations model developed in study 5. The modeling indicated that the nests most susceptible to dewatering and exposure occurred nearest to the outflow of the facility where the change in flow fluctuations and water surface elevations occur most rapidly.

316. There were six sites of interest in the Bellows Falls impoundment. Two sites were considered to have Project effects, meaning the nests could be dewatered as a result of Project operations in some or all model years. Three sites that had suitable habitat or active nesting were not affected by Project operations. One site was not assigned a Project effect because the habitat was determined to be unsuitable for sea lamprey spawning.

317. In the Bellows Falls riverine reach, there were three sites of interest. Two of the sites were determined to have some Project related effects where either suitable habitat or a nest site would be dewatered depending on the water year modeled. The third site was determined not to have any Project related effects and remained submerged in all modeled years.

K. Wildlife and Wetlands

318. The VWQS require the Secretary of the Agency of Natural Resources to identify and protect existing uses of state waters, which include those of surficial wetlands. The Standards prohibit activities that degrade the existing uses of wetlands. These uses can include fish and wildlife habitat, fishing, swimming, recreation, water quality maintenance, and others.

319. Additionally, many of the wetlands are classified as Class II wetlands and are protected under 10 V.S.A. Chapter 37 and the Vermont Wetlands Rules.

320. The Applicant identified wetlands within any land they owned plus a 200-foot buffer around the FERC identified project boundary. The wetlands were identified with the National Wetland Inventory as the primary source. Additional information was gathered from the USGS Land Cover Maps and the shoreland study conducted as part of the relicensing process. The following table is a summary of the acreage of different wetland types identified for the impounded reach above the dam and riverine reach below the Project (Table 20).

Table 20. Wetland types and amount in acreage within the Bellows Falls impoundment and riverine areas.

Cover Type	Bellows Falls Impoundment	Bellows Falls Riverine
Deciduous Forest	142.2	0
Coniferous forested	0	0
Mixed forested	0.4	0
Deciduous forested/shrub	26.8	0
Deciduous forested/emergent	1.0	0
Scrub-shrub	35.3	0
Scrub-Shrub/emergent	16.1	0
Emergent	241.0	0
Phragmites	4.7	0
Perennial stream	4.6	0.7
Intermittent stream	1.9	0
Pond	3.7	0
Possible vernal pool	1.3	0
Submergent aquatic vegetation	258.3	0
Total	478.9	0.7

321. A total of 478 acres of wetland habitat are within the Bellows Falls impoundment and 0.7 acres of wetland within the riverine reach below the Bellows Falls Project. These wetland types include a wide variety of types including forested, emergent, scrub-shrub, phragmites, submerged aquatic vegetation, and streams. Some of these wetlands include backwatered areas that would become dewatered during maintenance drawdowns or impoundment lowering.

322. The three wetland types that are most prevalent within the Bellows Falls impoundment are emergent, deciduous forest, and submergent aquatic vegetation. Deciduous forested wetlands are generally found in medium to large backwater areas, along point bars, and some tributaries. They are often made up of eastern cottonwood, silver maples, boxelder, and green ash among others. These wetland types are also known to have an herbaceous understory with a variety of fern types, in addition to both native and nonnative species.

323. Emergent wetlands are known to contain herbaceous hydrophytes, plants that can grow partially or totally submerged, for most of the growing season. Wetlands of these types include marshes, meadows, and fens. They are often dominated by broad-leaved cattails, rice cutgrass, woolgrass, American burweed, water-horse tail among others. These types of wetlands are typically saturated or frequently inundated. Emergent wetlands can be found in coves, protected shorelines, and the mouths of tributaries. In the Bellows Falls impoundment, there were located primarily in backwater areas and at the confluence of the larger tributaries.

324. Submerged aquatic vegetation consists of floating or submerged vegetation and typically grow in shallow water zones, which for the Project occur at the mouths of tributaries and in the lower ends of the impoundments. The most common vegetation species found in the Connecticut River for these types of wetlands were water lily, Eurasian water-milfoil, water celery, waterweed and water stargrass. Although these various species were most often located, they

varied in density and canopy cover depending on the location.

325. The wetlands were also assessed for values and functions. The Highway Method was used to evaluate the most common wetland types. Emergent wetlands were found to provide the most functions. The following table (Table 21) provides the six most common wetland types and the functions and values those provided.

Table 21. Six most observed wetland types and their functions and values provided within the Bellows Falls Project area using the Highway Method.

Wetland functions	Aquatic Bed	Emergent	Scrub/ Shrub	Scrub/Shrub Emergent	Forested	Forested Scrub/Shrub
Groundwater		X		X		
Flood flow Alteration		X	X	X	X	X
Fish and Shellfish Habitat	X	X				
Sediment/Toxicant Retention	X	X	X		X	X
Nutrient Removal	X	X	X		X	
Production Export	X	X				
Sediment/Shoreline Stabilization	X	X	X	X	X	
Wildlife Habitat		X	X		X	X
***Wetland Values**						
Visual Quality /Aesthetics	X	X				
Endangered species habitat	X	X	X		X	

*Additional wetland values were examined including recreation, educational/scientific value, and uniqueness/ heritage, but it was determined that those values were not provided at a principal level by any wetland type.

326. There is a wide variety of wildlife located within the Project area. A total of 87 species of wildlife were noted as incidental observations while conducting studies as part of the relicensing. These included, but not limited to, common merganser, wood duck, mallard, spotted sandpiper, bank swallow, belted kingfisher, green heron, bald eagle adults and juveniles, osprey, American kestrel, muskrats, American toads, spring peeper, bullfrogs, white tailed deer, racoon, mink, possum, and mice.

327. Wetland communities are subjected to a range of hydrologic influences. For example, those at higher elevations, like forested wetlands, may be primarily influenced by rainfall and runoff. Wetlands at lower elevations, like aquatic bed or emergent wetlands, may be more sensitive to drought or dewatering. These may also be most affected by artificial hydrologic alteration like operations of a peaking facility.

328. The Applicant investigated the impacts on aquatic communities that are likely to be affected by Project operations. This excluded those areas that are impacted during high flow events that are outside the capacity of the Project. The specific communities evaluated include aquatic vegetation and emergent and scrub/shrub wetlands. Water level fluctuations were recorded in Bellows Falls impoundment as part of an aquatic habitat mapping study.

329. There were two locations within the impoundment where wetland vegetation and a depth logger were within the same vicinity. Those were the confluence of the Williams River with aquatic vegetation and emergent and scrub/shrub wetlands. At this location, where the impoundment at the dam fluctuated 1.8 feet, the study site experienced water level fluctuations ranging between 1.8 to 2.8 feet depending on the location of the logger. This is in part due to the location of the site in the mid-impoundment. It would be expected that higher fluctuations would occur within the upper impoundment, while the lower fluctuations would occur in the lower impoundment or near the dam.

330. These wetland types occur in locations where some amount of physical protection is provided, for example within the backwaters and the mouth of the large tributaries. These areas are protected from extreme scour events and high currents, but exist at an elevation that provides continuous inundation.

L. Rare, Threatened, and Endangered Species

331. Several rare, threatened, and endangered species are possibly found within the Project area. These include, but are not limited to, puritan tiger beetle (*Cicindela puritana*), dwarf wedgemussel (*Alasmidonta heterodon*), northern long-eared bat (*Myotis septentrionalis*), Fowlers toad (*Anaxyrus fowleri*), cobblestone tiger beetle (*Cicindela marginpennis*), shortnose sturgeon (*Acipensier* brevirostrum), northeastern bulrush (*Scirpus ancitstrochaetus*), Sticky false asphodel (*Triantha glutinosa*), pine-drops (*Pterospora andromedea*) obedient plant (*Physostegia virginiana*), hairy pinweed (*Lechea mucronata*), harsh sunflower (*Helianthus strumosus*), and rattlebox (*Crotalaria sagittalis*).

332. While all rare, threatened, and endangered species have the potential to be affected by Project related activities, not all are subject to the VWQS. The following table includes those species considered as part of this Certification and the status of those species at either the state or federal level (Table 22).

Table 22. Rare, Threatened, and Endangered Species potentially located within the Bellows Falls Project Area. Status is listed at both the state and federal level. Federal status may be blank, if listing is not applicable.

Scientific Name	Common Name	VT Status [a]	Federal Status [a]
Invertebrate Animals			
Alasmidonta heterodon	Dwarf wedgemussel	E	E
Alasmidonta varicosa	Brook floater	T	
Cicindela marginipennis	Cobblestone Tiger Beetle	T	
Cicindela puritana	Puritan Tiger Beetle	T	T
Vertebrate Animals			
Anaxyrus fowleri	Fowlers Toad	E	
Acipenser brevirostrum	Shortnose Sturgeon	E	E

Myotis septentrionalis	Northern long-eared bat	E	E
Myotis sodalis	Indiana bat	E	E
Plants			
Scirpus ancistrochaetus	Northeastern bulrush	E	E

T=Threatened; E=Endangered.

333. In addition to those listed species in the table above, there are several dragonflies and damselflies listed as species of greatest conservation need in the state of Vermont. Additional species of greatest conservation need include fish species which are discussed in the aquatic biota and aquatic habitat sections of the Certification.

Northern Long-eared Bat

334. Northern long-eared bat (*Mytosis septentrionalis*) is federally listed as threatened and state-listed as endangered. This species winters in caves and cave-like structures, but summers in cavities, under bark or in hallows of live and dead trees. Tree maintenance has the potential to disrupt roosts between April 1st and October 31st. There are no known occurrences, habitat, or winter hibernacula of northern long-eared bat within a one-mile radius of the Project boundary.

Dwarf wedgemussel

335. Dwarf wedgemussel (*Alasmidonta heterodon*) is state and federally listed as endangered. Known occurrences of dwarf wedgemussel (DWM) occur within the Bellows Falls impoundment. DWM habitat includes slow to moderate velocities, with substrate preferences of gravel, sand, cobble. They do not prefer silty mud, but may be buried in sand with a small layer of silt.

336. The U.S. Fish and Wildlife Service has identified actions needed for DWM. These are to collect basic data needed for protection, preserve populations and occupied habitats, develop educational programs, conduct life history studies and identify ecological requirements of the species, re-establish populations within the species historical range, implement a program to monitor population levels and habitat conditions, and periodically reevaluate the recovery program.

337. For DWM, fertilization occurs in the summer or early fall with their glochidia being released the following spring. During fertilization sperm are released into the water column with female drawing in the sperm. Eggs are fertilized and develop within the outermost demibranches of the gills, with the earliest well developed glochidia occurring in the Connecticut River in early August.

338. Overwintering occurs for DWM as water temperatures begin to drop below 15°C. As temperatures fall, DWM begin to settle into the substrates submerged by water. Should that area become exposed to air, or the area is dewatered, DWM are at risk of freezing.

339. The glochidia are not released until spring beginning in early March. The glochidia must attach to host fish to complete their development. Additionally, this helps with dispersal of the species.

340. Host species for the DWM within the Project area include, tessellated darter (*Etheostoma olmstedi*), and slimy sculpin (*Cottus cognatus*). Tessellated darters were the primary focus for the DWM host species. Tessellated darter are known to occur in the Bellows Falls impoundment, although the distribution and habitat may be affected by project operations and therefore potentially affect DWM.

341. The Applicant conducted numerous studies related to DWM as part of the relicensing process. These studies included a habitat flow study, hydraulic modelling and operations reports, tessellated darter study, and development of habitat suitability criteria for the species.

342. Multiple fish surveys collected tessellated darters within the Bellows Falls impoundment and downstream reach. The quantity or catch-per-unit varied depending on the sampling technique used. However, the total number of darters observed and the catch per unit effort in the impoundment tended to be three times higher than in the reach downstream of the Project.

343. The tessellated darter study concluded that most individuals were collected in waters less than eight feet deep, tessellated darters were observed in locations of mussel activity or near mussel locations, and tessellated darters were widely distributed within the Bellows Falls impoundment.

344. The habitat flow study conducted by the Applicant concluded that tessellated darter have relatively moderate available habitat at the lowest flows, the available habitat increases and maximizes near 2,000 cfs then gradually begins to decrease.

345. DWM were also part of the habitat flow study, (Findings 239 - 253). The steady state analysis from the study indicated that DWM had a steady decline with increasing flow. Additionally, the dual flow analysis showed that the amount of habitat that remains under either a dual flow or two flow analysis is greatest when the magnitude of change is reduced.

346. In addition to the downstream flow considerations, there are mussels located within the impoundment. The operations study indicated that there are potential impacts on DWM associated with the water level fluctuations under current operations.

347. As part of the relicensing effort, the Applicant conducted field surveys for DWM within the Wilder impoundment, the riverine reach below Wilder, the Bellows Falls impoundment and riverine reach, and the Vernon impoundment. During the field survey for DWM, 61 sites within the Bellows Falls impoundment were surveyed. DWM were found at 14 of the 61 sites (23.0 %) located primarily in the upper 17 miles of the Bellows Falls impoundment.

348. A total of 69 DWM were found during the survey of the study areas, with a total of 24 DWM being found in the Bellow Falls impoundment for an average of 0.39 mussels/site and an average catch per unit effort (CPUE) of 0.30 mussels/hour. The average shell length was 31.5 mm, with a minimum length of 10.0 mm and a maximum length of 4450 mm. Additionally, the field survey found evidence of recruitment within the Bellows Falls impoundment. Nearly all DWM were found in water depths of 6 to 20 feet using scuba gear. Snorkeling near shore areas

during the survey was ineffective.

349. While no individual DWM were found in the area subject to frequent water level management during the survey, the time spent moving in response to relatively rapid changes in water level that occur under current operations may affect DWM.

350. Under the Applicant's proposal of IEO with flexible operations, there is an increase in persistent habitat by stabilizing and reducing impoundment fluctuations and providing multiple consecutive day periods at IEO each month during the DWM active period from April 1 through October 15 (>3 days) (see Table 8 and Table 17). Periods of IEO are intended to facilitate successful breading and support life cycle requirements.

351. Additionally, the Applicant's proposal includes a component to protect DWM overwintering habitat. The pre-winter habitat protection operation is intended to create overwintering habitat that is protected from potential water drawdown that could expose mussels. As discussed in Finding 325, mussel activity drops when water temperatures drop below 15°C. The Applicant is proposing to lower the water level at the Project to an elevation at or above the low limit of flexible operation impoundment range and maintain it at the elevation for a limited period of time (estimated at 10 to 21 days) during which water temperature is consistently dropping from 15°C to 10°C. This will likely occur in late October to early November.

Dragonfly and Damselfly

352. Dragonfly and damselfly species belong to the order Odonata and are referred to as odonates. Seven of Vermont's species of greatest conservation need (SGCN) dragonflies and damselflies (odonates) occur within the Wilder, Bellows Falls, and Vernon project affected area.

353. Of those seven odonates, four were located within the Bellows Falls project affected area. These included *Gomphus abbreviates, Gomphus vastus, Stylurus amnicola*, and *Stylurus scudderi.* All these species were observed at multiple transects within the Bellows Falls riverine or impoundment reaches.

354. Odontates spend one or more years as a larval stage within the water. The larvae then exit the water to shed its larval exoskeleton for the adult form to emerge, referred to as eclosure. The adult form then spends a short time drying the newly exposed exoskeleton, teneral phase, before the adult can take flight.

355. There are two phases where odonates are vulnerable, particularly to flow fluctuations. The first is during the eclosion phase when the newly emerged adult exoskeleton is not yet dry. During this phase, the individual are not able to move to take flight.

356. The second instance when the Odonate is vulnerable to flow fluctuation is during the teneral phase, when the exoskeleton has dried, but the individual cannot take flight. During this phase, individuals have some ability to climb the riverbank or vegetation in response to threats.

357. In the review of literature, it is estimated that the total time from moving out of the water, completion of eclosion, and shedding old exoskeleton is 30 to 40 minutes. It is anticipated that the peak flight period for all seven SGCN Odonates ranges from May 21st to July 31st. Observations of adults have occurred as late as September 20th.

358. For the GRH project affected areas, the majority of the species observed in the odonate study were the species *Gomphus vastus* (focal species) and *Stylurus spiniceps*. A total of 754 observations were made of Odonates or their exuviae.

359. For the GRH project affected areas, odonate surveys were conducted between 0:700 and 20:00 hours. Eclosion was observed before the start of the survey with the latest occurring at 16:53 hrs. This suggests that eclosion occurs for a longer period of time throughout the day than previously thought. Eight individuals were observed during the start to end of eclosure phase. This ranged from 20 to 45 minutes with an average of 31 minutes.

360. Within the Bellows Falls Project affected area, a total of 237 odonate observations were made. No observation of teneral or eclosure phase were made during the study. There were 14 observations of larvae emerging during the study. The distance from the waterline for the emergence phase individuals was between 4 inches to 33 inches with an average of 13 inches. For the exuviae observations, they ranged from 0 inches to 72 inches with an average of 24 inches above the waterline.

361. The elevation of the waterline was subject to change during the study as water levels fluctuated. Therefore, some vertically measured exuviae could have been further from the waterline or closer to the waterline when eclosion took place.

362. During the study period, the water level at the transects located in the Project impoundment ranged from 2.7 feet at one site and 2.8 feet at the other site. In the riverine section, water level fluctuation ranged 10.3 feet during the study period.

Cobblestone and Puritan Tiger Beetles

363. Puritan tiger beetle (*Cicindela puritana*) is listed as federally threatened and as threatened in the state of Vermont. It is listed as endangered in the state of New Hampshire. The Puritain tiger beetle has historically existed within the Connecticut River but has not been observed any further north than Hadley, Massachusetts in the last 25 years.

364. Cobblestone tiger beetle (*Cicindela marginipennis*) are listed as threatened in both New Hampshire and Vermont. Cobblestone tiger beetle (CTB) have been located within the GRH project affected areas. CTB are typically found on cobble and gravel beaches on medium and large rivers. Larvae may dig burrows in wet sand found between cobbles, however very little is known about CTB burrows or larvae as they have not been taxonomically described.

365. GRH conducted a study with a focus on CTB because of more recent confirmations of the species in the Project affected areas. The focus was on the adult stages of CTB given the challenge of correct identification of larval burrows from other species of tiger beetles.

366. CTB adults are most actively foraging and breeding during June, July, and August. It is thought that larval tiger beetles burrow for 1 to 2 years, although the exact duration is unknown. Additionally, it is thought that larvae can withstand some amount of inundation, but the duration and frequency vary among species and the tolerance is unknown for CTB.

367. Within the Bellows Falls Project affected area, eight study sites were located based on previously recorded observations, and in areas where habitat was suitable for CTB. For the

Bellows Falls project affected area, six sites were located within the impoundment and two were located in the riverine section downstream of the dam.

368. CTB were identified at three of the eight study sites, with two locations being within the impoundment and one being located downstream. At an additional two sites in the impoundment, one CTB may have been observed during the survey period but with low certainty. At each of the study sites where CTB were identified, it was estimated that there were 1.68 acres, 0.15 acres, and 0.61 acres of habitat available.

369. The minimum and maximum habitat elevation was measured at each study site. Additionally, GRH used a model developed as part of the relicensing to estimate the maximum modeled water surface elevation that might occur at each CTB site. This can be accomplished under the proposed operations (Finding 106) and under IEO conditions (Finding 57 and 58) for a series of years (2009, 2015, 2016, 2017) and limited months. In this case, the months analyzed were June and August of each year, when it is anticipated that CTB will be most active.

370. The tables below are limited to specific nodes (locations of transects where water surface elevation was estimated) where CTB were located within the area affected by Bellows Falls operations. This nodal information was provided in the Study 26 report. The tables indicate the difference between the average maximum daily water surface elevation and the daily minimum water surface elevation. Table 23 represents proposed operations and Table 24 represents Project operation in a strict IEO mode of operation.

Table 23. The difference between the average maximum daily water surface elevation and the daily minimum water surface elevation for specific locations where Cobblestone Tiger Beetles were located in the Bellows Falls Project area. Values are based on the modeled proposed operations for different water years and months of interest. The months in the table below are limited to those time frames when Cobblestone Tiger Beetles are anticipated to be active.

Year	Month	Chase Island Node 709	Ascutney Riverbank Node 671	Walpole Island Node 448
2009	June	1.4	1.1	1.1
	Aug	1.4	1.0	1.1
2015	June	1.5	1.3	1.6
	Aug	1.0	0.6	1.3
2016	June	0.7	0.4	0.8
	Aug	0.9	0.5	0.7
2017	June	1.3	1.0	1.2
	Aug	0.8	0.4	1.1

Table 24. The difference between the average maximum daily water surface elevation and the daily minimum water surface elevation for specific locations where Cobblestone Tiger Beetles were located in the Bellows Falls Project area. Values are based on the modeled operations if the Bellows Falls Project operated in an inflow equal to outflow mode for different water years and months of interest. The months in the table below are limited to those time frames when Cobblestone Tiger Beetles are anticipated to be active.

Year	Month	Chase Island	Ascutney Riverbank	Walpole Island

		Node 709	Node 671	Node 448
2009	June	1.3	0.9	1.0
	Aug	1.3	1.0	1.0
2015	June	1.6	1.4	1.6
	Aug	0.9	0.5	0.7
2016	June	0.7	0.5	0.7
	Aug	0.7	0.3	0.6
2017	June	1.2	0.9	1.2
	Aug	0.5	0.2	0.5

Fowlers Toad

371. Fowlers Toad (*Anaxyrus fowleri*) is listed as endangered in the state of Vermont and is a species of greatest conservation need in New Hampshire. This species habitat requires a mix of both wetland pools and bare soils. The toad's habitat may benefit from the occasional shoreline disturbance to keep the areas unvegetated and so that the floodplains may provide small pools for breeding.

372. GRH conducted a survey of Fowlers Toad within the project affected areas. Potential sites were first identified from previous records and aerial imagery that could contain appropriate habitat. Sites were then visited to confirm aerial imagery and access.

373. Fifteen study sites were identified across the Wilder, Bellows Falls, and Vernon project affected areas. However, through the course of the study, some were determined to be outside of the project affected area, or unsuitable habitat for Fowlers toad.

374. Study sites were surveyed by both standard call surveys where surveyors go the site and listen for a predetermined amount of time when Fowlers Toad is likely to call and acoustic monitoring where equipment was used to record sounds to be listed to at a later date. Although standard call surveys are preferred given the Fowler's toads unique call, both methods were used because four of the 15 sites were challenging to get to, particularly at night.

375. For the standard call survey, each site is visited three times with roughly two weeks between each visit. At each site, the surveyors spent three minutes listening and recording call after sunset. For acoustic monitoring, equipment was set up at the site and set to record nightly from 8:00 p.m. to 11:00 p.m.. Data was saved on an SD card for later retrieval and listening.

376. Of the 15 sites, six were in the Bellows Falls impoundment. No calls of Fowlers toads were heard within any of the Bellows Falls impoundment sites during the study.

Northeastern bulrush

377. Northeastern bulrush (*Scirpus ancistrochaetus*) is listed as federally endangered, as well as endangered in both Vermont and New Hampshire. The Northeastern bulrush is a perennial species in the sedge family. This species prefers habitats with an open canopy and intermittently variable water tables. The Northeastern bulrush requires bare substrate for flowering and germination.

378. Initial survey identified three sites within the Bellows Falls impoundment to be surveyed for the Northeastern bulrush. Two of the three sites were determined to have suitable habitat for Northeastern bulrush, including one location where it was previously observed in 1999. However, the field surveys did not find northeastern bulrush during the survey.

Shortnose Sturgeon

379. Shortnose sturgeon is listed as endangered federally as well as in Vermont. The shortnose sturgeon is the smallest of the sturgeon species growing to a length of four feet and can live up to 30 years or more, and do not reach reproductive maturity until they are 10 to 12 years old.

380. The historic range of the population in the Connecticut River was widely accepted by researchers and managers to be from the mouth of the river at Long Island Sound to Great Falls, where Turners Falls dam was built in 1905, as the falls were believed to be a natural barrier.

381. In recent years, shortnose sturgeon have been documented below the Bellows Falls Project. The documentation includes video taken below the Project of sturgeon in 2022, and documentation of possible sturgeon in a flooded field in 2023. In 2024, a study employing environmental DNA techniques documented the presence of shortnose sturgeon DNA within the reach below the Project. However, researchers believe that the population is likely at lower numbers than the population downstream in the Connecticut River due to the strength of the detection compared with the control.

382. The National Marine Fisheries Service (NMFS) is the federal agency responsible for research and prescribing conservation and management needs for the endangered shortnose sturgeon. Currently, there is little to no information on the number of shortnose sturgeons present in the reach of the Connecticut River below the Project or if spawning is occurring. NMFS is working with partners to better understand the population of sturgeon in this reach of the Connecticut River and any potential conservation or management needed to protect them.

M. Recreation

383. The Bellows Falls Project area encompasses 835 acres of land, of which 86 acres are set aside for public outdoor recreational use. The land immediately adjacent to the dam and powerhouse consists primarily of industrial and residential development. In addition, to the recreational facilities that are associated with the Project and owned and maintained by the Applicant, there are several other recreational facilities located along the Connecticut River in the vicinity of the Project not directly owned by the Applicant.

All Recreational Activities

384. The Applicant conducted a recreation facility inventory, use, and needs assessment in 2014-2015 as part of the relicensing effort. There were multiple components to the assessment including an initial inventory of recreational opportunities, in-person surveys for individuals utilizing recreational areas, a questionnaire mailed to people living in the region, and an estimate of future use and capacity at recreation locations. When applicable, the study distinguished between two seasons: the peak season representing May 1 through October 15, and the remainder of the year was considered off-peak season.

385. The Applicant identified several recreational facilities within the Project area. These included Ashley Ferry Boat Landing, Hoyts Landing, Patch Park, Charlestown boat launch, Herrick's Cove, Pine Street boat launch and portage take-out, Bellows Falls fish ladder and visitor center, Bellows Falls portage put-in, Connecticut River Car-top, and Cold River hand-launch site.

386. Of the facilities listed above, Herrick's Cove, the Charlestown boat launch, Pine Street boat launch and take-out, and the Bellows Falls fish ladder and visitor center are on land owned by the Applicant.

387. Additionally, the Lower Meadow Campsite is a non-Project primitive campsite along the Connecticut River Paddlers' Trail that is on Great River Hydro owned land in South Charlestown, New Hampshire.

388. The current portage trail around Bellows Falls dam is 1.5 miles long. From the take-out at the Pine Street boat launch the trail follows residential streets for 0.4 miles before continuing along the shoulder of Route 12 for 1.1 miles, it then turns down a paved access road to the river and the put-in location, which is located outside the Project boundary.

389. The recreational facilities owned by the Applicant had an estimated number of recreational use days of 97,550 from March 2014 through February 2015 with use of the Charlestown boat launch and Herrick's Cove accounting for 97 percent of the overall use. The remaining recreational facilities not owned by the Applicant had an estimated number of recreational use days of 214,576 with Hoyts Landing accounting for 46 percent of the recreational use days.

390. In addition, the Applicant estimated the average duration of a trip for visitors. At the Project during peak season, the minimum number of hours spent was one, the maximum number of hours spent was 12, with the average number of hours spent being 3.3. The activity that had the longest duration was fishing from either boat or ice fishing, motorboating (not fishing), followed by jet skiing/personal watercraft use and other. All other activities were reported as having a duration of less than four hours.

391. The onsite interviews allowed the Applicant to estimate the distribution of recreational activities for those who were onsite. The most common activity reported was fishing from the shore with 34 percent of respondents participating in this activity, followed by picnicking and family gathering at 16 percent.

392. From individuals who were interviewed on site, there were similar responses in the percentage of primary activities reported when visiting the Connecticut River. These include fishing from the shore (32.1%), Canoeing/kayaking- flat water (12.9%), fishing from a boat or ice fishing (12.1%) and picnicking and family gathering (11.4%).

393. When onsite visitors filled out the survey, they were asked how scenic and safe the recreational area was. The responses are provided in Table 25.

Table 25. Responses from onsite interviewees on various Bellows Falls Project area recreational area based on scenic quality and feelings of safety.

Scenic Quality	Safety Ratings Bellows Falls study area	Safety Ratings Bellows Falls Project

Number of responses	Rating	Reference values	Number of responses	Rating	Reference values	Number of responses	Rating	Reference values
72	9	Extremely appealing	66	9	Extremely safe	39	9	Extremely safe
15	8		3	8		3	8	
28	7	Appealing	12	7	Safe	12	7	Safe
0	6		0	6		0	6	
24	5	Average	2	5	Neither safe nor unsafe	2	5	Neither safe nor unsafe
0	4		0	4		0	4	
1	3	Unappealing	0	3	Unsafe	1	3	Unsafe
0	2		0	2		0	2	
0	1	Not at all appealing	0	1	Not safe at all	0	1	Not safe at all

394. For scenic quality, the majority of individuals interviewed gave the sites the highest scenic quality response at rates consistent with overall results. Sites that received a low score in the Project area typically were related to trash and brush. Additionally, the majority of respondents indicated they felt the sites were extremely safe. However, one respondent at Herrick's Cove reported unsafe conditions and recommended the site be patrolled by police.

395. When respondents noted in the questionnaire that they felt safe, there were still often comments about how safety could be improved at recreational sites. Some of these related to recognizing that recreational activities have risk, and a certain amount of individual responsibility is required. This was particularly relevant when related to increases in flow released from the dams.

396. When onsite via interview, participants were asked about their satisfaction with the recreational facilities and most reported being satisfied with the current existing facilities. Opportunities for improvements were noted and common suggestions included removing trash and adding additional boat ramps. Responses suggesting adding bathrooms and improving road conditions were also common.

397. Specific to Applicant owned properties, two individuals noted dissatisfaction with the Charlestown boat launch, specifically that the boat launch was unusable and issues with trash. Another respondent noted issues at the Pine Street boat launch related to launching and loading their boat due to the lack of a concrete pad for traction.

398. Regional mail survey respondents were also asked if they had visited any of the recreational facilities offered, and if not, why. The responses for why included distance, lack of familiarity, and not having interest in recreational activities related to water or near water.

399. The respondents to the regional mail survey also offered recommendations on specific types of facilities needed at the Bellows Falls area sites. Some recommendations for the Bellows Falls Project included better boat access, including docks and launches and improved picnic areas.

400. The Applicant reviewed the recreational facilities for adequate parking, in addition to

reviewing adequacy for future use. The recreational facilities were generally found to be adequate except for the facilities listed below.

401. The Charlestown boat launch was found to be in poor condition during the assessment with observations of people looking to launch their boat, but after assessing the condition of the boat launch, leaving without doing so. It is believed this led to underuse during the assessment period. The boat launch area was closed shortly after the study and repairs were completed in 2018. This included replacing a grill, replacing the wood parking ties with boulders, re-grading the parking area, temporarily converting the trailered boats launch to a hand-carry launch due to safety concerns until the new trailered boat launch could be designed and constructed.

402. There were several comments submitted to the FERC record related to recreational facilities for the Project. Some of the comments included that the Applicant should fund projects to mitigate the economic and recreational impacts of the Project, develop an upstream takeout and portage on the Vermont side of the river, and add additional facilities to access the river.

Boating

403. The management objectives for waters classified as Class B(2) for boating are "[w]aters shall be managed to achieve and maintain a level of water quality compatible with good quality boating (Standards, Section 29A-306(d)(3)(A)). The Class B(2) criteria for boating use is "waters shall comply with the Hydrology Criteria in Section 29A-304 of these rules" (Standards, Section 29A-306(d)(3)(B)).

404. A state may adopt subcategories of a designated use and set the appropriate criteria to reflect the varying needs of such subcategories of the uses.[13] However, the State is not required to adopt subcategories of designated uses and selects the level of specificity it desires for identifying designated uses and subcategories of uses, as long as they are least as specific as the uses listed in sections 101(a) and 303(c) of the federal Clean Water Act.[14] The Department has not adopted any subcategories of the designated use of recreational boating.

405. The Department manages waters to achieve and maintain a level of water quality compatible with good quality boating, in general, and not particular types of boating. Although some waters or reaches may support different boating types depending on its characteristics and hydrology.

406. There are many types of boaters who utilize the Connecticut River for recreation. This includes motorboaters, scullers, canoeing and kayakers. Of those are through boaters who travel longer distances on the Connecticut with boats that contain gear typically used for overnight trips. Additionally, there a group of users that primarily utilize the river for boating for day outings Another group consists of whitewater boaters, who may through travel, but are primarily interested in areas with elevation drops that create boatable features. These features vary in difficulty and type depending on the area and flow.

407. From the survey done within the Bellows Falls study area, of onsite interviews indicated that

[13] 40 C.F.R. § 131.10 Designation of uses
[14] U.S. Environmental Protection Agency (EPA). 2012. *Water Quality Standards Handbook: Chapter 2: Designation of Uses.* EPA-823-B-12-002. EPA Office of Water, Office of Science and Technology, Washington, DC. Accessed November 2024. https://www.epa.gov/sites/default/files/2014-10/documents/handbook-chapter2.pdf

15 percent of respondents were there for flatwater boating with a canoe or kayak, 4 percent were at the river for motorboating, while 1 percent of respondents were participating in whitewater kayaking or canoeing, a multiple day float trip, or using a personal watercraft, respectively.

408. For those who responded to the regional mail survey, which included all the Connecticut River hydroelectric projects, the percentages for flatwater boating (canoe/kayak), motorboating, whitewater kayaking/canoeing, multiple day float trip, or using personal watercraft were 74, 22, 10, 7, and 0 percent, respectively. Several mail-in respondents selected multiple activities, so the total percentages exceeded 100 percent (Table 26).

409. The primary activity that individuals identified when participating in the onsite interviews was flatwater canoeing/kayaking at 12.9 percent, motorboating at 3.6 percent, while whitewater kayaking/canoeing, multiple day float trip, sculling, and using a personal watercraft were all at 0.7 percent, respectively. For those who responded to the regional mail survey, which includes all Connecticut River hydroelectric projects, the percentages were 21.2, 2.4 with other uses reported as 0 percentage of respondents, respectively (Table 26)

Table 26. Primary activity reported by onsite interviewees and main survey respondents as a percentage of all various activities in the Project area. Mail survey resident responses are not Project specific.

Activity type	Bellows Falls interviewees	Mail survey resident respondents
Canoeing/Kayaking- flat water	12.9%	21.2%
Motorboating	3.6%	2.4%
Canoeing/Kayaking- white water	0.7%	0%
Sculling	0.7%	0%
Multiday float trip	0.7%	0%
Personal Watercraft	0.7%	0%

410. Through-paddling for both day trips and longer trips is a popular activity, in general. The Connecticut River Paddlers' Trail provides paddlers with an opportunity for multiple day float trips with over 55 camping destinations and over 150 access locations.

411. The Connecticut River Paddlers' Trail extends from the headwaters in the Great North Woods of New Hampshire to the Long Island Sound. There are over 20 organizations that assist with building and maintaining the network, including campsites, access points, portage trails, and providing information to travelers.

412. As part of the relicensing, the Applicant, as required by FERC, undertook a phased study to determine the suitability of the Bellows Falls bypass reach for whitewater boating. Under current operations, no minimum conservation flow is required to be passed into the bypass

reach and when the river is within the hydraulic capacity of the Project the only flow provided into the bypassed reach is leakage, which occurs through the gates and flashboards. High flows occur in the bypass when flow in the river exceeds Project capacity which typically occurs during the spring freshet, but can, and has, occurred during high flow events that can occur any time of year.

413. Currently, boating has not been permitted or encouraged in the Bellows Falls bypass reach due to safety concerns from high flow danger conditions, and the lack of suitable ingress and egress to the reach. There are signs posted throughout the reach warning of sudden changes in water levels due to dam spill.

414. The first phase of the study, to assess the suitability of boating in the Bellows Falls bypass, was to have study participants gather to assess access to the reach, view video of late winter and spring spills through the spillway at flows up to 20,000 cfs, and to evaluate spill from the shoreline and the Vilas Bridge at flows ranging from 2,500 to 7,500 cfs. After review of the various flows, the study participants concluded that the reach was boatable at more than one flow, so a multi-flow assessment of the reach was planned.

415. As part of the multi-flow assessment, the Applicant provided various flows from the dam into the bypass reach for boaters to evaluate. There were twelve boaters who participated in the study. The volunteers participating used kayaks and canoes and self-reported as advanced to expert boaters.

416. The flow evaluation for the Bellows Falls bypass reach took place on May 30th and 31st, 2015. During the evaluation participants had the option to boat nine different flows over the weekend (Table 27). Participants were asked to complete two types of surveys, a single flow survey and a comparison flow survey. However, not all participants boated all flows for various reasons (safety concerns, energy retention, ability to stay for the duration of the study). Over the course of the flow evaluation, between 4 and 11 boaters completed surveys at each flow.

Table 27. Whitewater paddling study flows at the Bellows Falls bypass reach for targeted and measured flows.

Date	Flow No.	Target Flows (cfs)	Actual Flow Measured at spillway gate (cfs)
5/30/2015	1	2,200	2,370
	2	3,500	3,300
	3	4,500	4,370
	4	5,500	5,560
5/31/2015	5	1,500	1,580
	6	2,000	2,020
	7	3,000	2,900
	8	7,500	7,400
	9	10,000	9,660

417. In the surveys, the participants were asked to rate each flow on various characteristics including navigability, whitewater challenge, safety, and aesthetics. Additionally, the participants were asked to indicate their preferred flow preference and to compare the Bellows Falls bypass reach with other boating reaches in the region.

418. Generally, participants rated the lower and mid-level flows as class II to III+. Most participants ranked higher flows between class III to IV. Additionally, each participant rated the likely skill level required to successfully boat the Bellow Falls bypass (Table 28).

Table 28. Participants rated suggested skill level required to successfully boat the Bellows Falls bypass reach.

Skill Level Required	1,500 (cfs)	2,020 (cfs)	2,370 (cfs)	2,900 (cfs)	3,300 (cfs)	4,370 (cfs)	5,560 (cfs)	7,400 (cfs)	9,600 (cfs)
Novice			1		1				
Beginner	4	3	1	2	1	2	2		
Intermediate	3	1	8	2	8	6	3	2	
Advanced			1			2	3	4	6

419. The following table presents the average scores of different watercraft types, given a characteristic of interest. Kayaks being the majority are presented in Table 29, while canoes are presented in Table 30. Values are rated from 1 to 7, with 1 being totally unacceptable, 4 being marginal, and 7 being totally acceptable. The total number of participants who rated that flow is denoted by 'n.'

Table 29. Whitewater flow characteristics by flow from participants using kayaks. Ratings are from 1 to 7 with 1 being totally unacceptable and 7 being totally acceptable at Bellows Falls bypass reach.

Characteristic	1,580 (cfs) n=6	2,020 (cfs) n=4	2,370 (cfs) n=9	2,900 (cfs) n=4	3,300 (cfs) n=8	4,370 cfs n=8	5,560 (cfs) n=7	7,400 (cfs) n=5	9,660 (cfs) n=6
Navigability	6.2	6.0	7.0	5.8	6.8	6.6	6.6	6.6	6.7
Technical Rapids	4.2	5.0	5.0	4.8	5.0	5.3	5.9	6.2	6.3
Powerful Hydraulics	3.7	4.0	4.6	4.3	4.9	5.9	5.7	5.8	6.0
Playboating Areas	4.0	5.3	5.0	3.5	4.3	6.0	5.1	4.2	4.0
Overall Whitewater challenge	4.7	4.5	5.1	4.5	4.8	5.6	5.7	5.8	5.8
Safety (flow)	5.3	6.0	6.6	5.8	5.6	5.6	4.9	5.2	5.3
Safety (debris/hazards)	5.3	5.8	6.0	5.5	5.9	6.1	6.3	5.2	5.0
Hazards present	6.0	5.8	6.0	5.8	6.4	5.4	6.0	5.0	5.2
Aesthetics	5.5	5.8	5.8	5.8	5.3	5.6	5.2	5.8	6.0
Length of run	4.2	4.0	4.4	4.3	4.6	4.6	4.7	4.6	4.5
Instruction potential	5.7	5.8	6.1	5.3	4.4	4.8	5.2	3.6	3.5
Overall rating	4.7	5.5	5.6	4.8	4.8	5.6	5.5	5.4	6.2

Table 30. Whitewater flow characteristics by flow from participants using a canoe. Ratings are from 1 to 7 with 1 being totally unacceptable and 7 being totally acceptable at Bellows Falls bypass reach.

Characteristic	1,580 (cfs) n=2	2,020 (cfs)	2,370 (cfs) n=2	2,900 (cfs)	3,300 (cfs) n=2	4,370 cfs n=2	5,560 (cfs) n=1	7,400 (cfs)	9,660 (cfs)
Navigability	6.0	-	6.5	-	6.5	6.5	5.0	-	-
Technical Rapids	6.0	-	4.5	-	5.0	5.0	4.0	-	-
Powerful Hydraulics	6.0	-	4.0	-	5.0	5.0	5.0	-	-

Playboating Areas	6.0	-	4.0	-	5.5	5.5	5.0	-	-
Overall Whitewater challenge	6.0	-	5.0	-	5.5	5.5	5.0	-	-
Safety (flow)	6.0	-	6.0	-	6.0	6.0	5.0	-	-
Safety (debris/hazards)	6.5	-	6.5	-	6.5	6.5	6.0	-	-
Hazards present	6.5	-	6.5	-	6.5	6.5	6.0	-	-
Aesthetics	5.0	-	5.0	-	5.0	5.0	5.0	-	-
Length of run	3.5	-	2.5	-	3.0	3.0	2.0	-	-
Instruction potential	5.5	-	4.0	-	4.5	4.5	4.0	-	-
Overall rating	6.0	-	5.0	-	5.5	5.5	5.0	-	-

420. The minimum reported characteristic for all flows for kayaks was 3.5 on average for "playboating areas" at a flow of 2,900 cfs and "instruction potential" at a flow of 9,660 cfs. While the "length of the run" consistently received the lowest score from participants using canoes.

421. As part of the flow evaluation, participants were asked what they considered the minimum acceptable flow and the optimal flow relative to the flows evaluated. Both minimum and optimal flow ranges were different between canoe and kayak user groups. The canoe users' scores converged around a minimum flow between 1,500 cfs and 2,370 cfs. The kayakers minimum acceptable flow converged around two areas. The first between 2,020 and 3,300 cfs and a second minimum flow around 4,370 cfs.

422. In general, the canoers optimal flow preference appeared to be between 2,370 to 3,000 cfs. Due to the limited number of participants, it was difficult to find a preferred optimum flow. For the kayakers, the greatest number indicated a flow somewhere between 2,370 cfs and 3,300 as the preferred optimum flow. Scores indicated that a flow 2,900 cfs was close to the optimum flow for this group. A second convergence of kayakers scores for their preferred optimum flow occurred between 4,370 cfs and 5,560 cfs, with the responses suggesting 5,000 cfs.

423. Additionally, participants were asked to compare the Bellows Falls bypass reach to other reaches within a two-hour drive and throughout New England (Table 31). Overall, kayakers rated the boating in the Bellows Falls bypass reach as above average to average to other in the region while canoers rated it average to below average.

Table 31. Participants comparison of boating in the Bellows Falls bypass reach with other boatable reaches in the region and New England.

Comparison	Average Rating[a]	Minimum Rating[a]	Maximum Rating[a]	Standard Deviation
Kayaks				
Compared to other reaches within 2-hour drive of Bellows Falls	4	2	5	0.7

Compared to other reaches in New England	3.1	2	5	1
Canoes				
Compared to other reaches within 2-hour drive of Bellows Falls	3	2	3	0.9
Compared to other reaches in New England	2	2	2	0

[a] Key to Rating Scale
1 = worse than average
2 = below average
3 = average
4 = above average
5 = much better than average

424. The Applicant is proposing to operate the Project in an IEO mode with flexible and transition operations. The proposed operations as modeled would offer opportunities when flow into the bypass reach exceeds 1500 cfs. While the number of hours varies by year, modeling suggest both a slight increase in opportunities and decrease in opportunities depending on the hydrology of the year in question. In addition, modeling shows that the impoundment level will be maintained at the target level at a higher poroportion of the time relative to current operations, which is likely to result in increased spillage under the proposed operations.

425. While the evaluation completed by the Applicant in Bellows Falls bypass focused on one specific type of boating, whitewater, the boatability of the bypass can be evaluated using existing information for flatwater canoeing or kayaking as well. Using the depth and velocity calibration dataset from the instream flow study completed in the Bellows Falls bypass reach allows assessment of the depth at the transects through the reach (Study 9). As stated in finding 221 due to the geomorphology of the channel the flow was contained to the main channel, so depth increased faster than the wetted width.

426. The maximum depth of the water at the transects through the Bellows Falls bypass reach at the calibration flow of 286 cfs ranged from 2.5 feet to 5.5 feet. The width of the channel with the deepest flows ranged from 20 feet to 50 feet.

427. Review of the criteria of the depth and width to define a boatable channel have found that a depth of eight inches is suitable for open canoes and kayaks with the width being slightly larger than the width of the boat being used.[15] Given this criteria and the results from the hydraulic modeling done as part of the habitat-flow study, the waters of the Bellows Falls bypass reach

[15] Whittaker, D., B. Shelby, W. Jackson, and R. Beschta. 1993. *Instream flows for recreation: a handbook on concepts and research methods.* U.S. Department of Interior, National Park Service, Anchorage, AK.

would this criteria at 300 cfs.

428. However, as stated above, currently boating has not been permitted or encouraged in the Bellows Falls bypass reach due to safety concerns related to high flow conditions and the lack of suitable ingress and egress to the reach. Public access to the bypass reach is an obstacle to formal boating opportunities. While there are informal trails, typically down steep embankments, these cross privately owned land or are adjacent to roads and railroad property. On the Vermont side of the river, the land adjacent to the bypass reach is owned by the railroad and access would require crossing active train tracks which would potentially create additional public safety concerns.

N. Debris

429. The Project is equipped with a hydraulic trashrack rake, which is used to pull river debris away from the unit intakes. The rake is driven to the trashracks in front of each unit intake on a set of tracks that are located on top of the forebay intake structure.

430. The rake is manually operated. To remove debris, the rake head is lowered to the bottom of the trashrack and retracted upward along the rack to remove debris. Debris is then conveyed to a trailer for removal.

431. There is an ice sluice/skimmer gate located on the east side of the forebay that is 12 feet wide by 10 feet high that can also be opened to pass river debris. It was unclear from the FLA what types of debris can be associated with this flushing or under what circumstances either methodology is employed.

O. Aesthetics

432. The management objectives for waters classified as Class B(2) for aesthetics are "[w]aters shall be managed to achieve and maintain good aesthetic quality" (Standards, Section 29A-306(c)(3)(A)). The Class B(2) criteria for aesthetics in rivers and streams are "[w]ater character, flows, water level, bed and channel characteristics, and flowing and falling water of good aesthetic value" (Standards, Section 29A-306(c)(3)(B)(i)).

433. The Project impoundment extends roughly 26 miles upstream. The land adjacent to the impoundment is characterized as villages, farmlands, country roads, and mountainous terrain. The Project area is visible from several locations including recreational locations owned by the Applicant and others.

434. Information related to the aesthetics of the waters affected by the Project were specifically collected for the bypass reach. Additionally, questions related to aesthetics were asked as part of the recreational needs and assessment study, where individuals referenced the area's cleanliness, vegetation, or vandalism.

435. Additional comments in the record referenced muddy shorelines, which was noted by the Applicant to occur often at the confluence with tributaries when flood profile operations needed to be conducted. This type of occurrence can also occur during peaking operations.

436. As part of the relicensing effort, the Applicant conducted an aesthetic flow study in the Bellow Falls bypass reach. The study assessed various flow levels in the bypass reach and provided for

an aesthetic rating for the different flows.

437. The initial study collected data in May 2015, which included photos and videos of six flows from three observation points. The flows observed were ~125 cfs (leakage), 1,580 cfs, 2,370 cfs, 3,300 cfs, 4,370 cfs, and 5,560 cfs. The initial flows were associated with the whitewater boating flow assessment. The observation points from upstream to downstream included the Arch Bridge, from the sidewalk looking over the dam into the bypass reach; from New Hampshire Route 12 (River Street or Main Street); and from the now-closed Vilas Bridge (Bridge Street).[16]

438. The Applicant convened a focus group of nine participants to view the series of videos of the different levels of flow in the bypass reach taken from the observation points. Each participant rated the flows on a seven-point scale ranging from -3 ("totally unacceptable") to +3 ("totally acceptable") with a 0 midpoint ("neutral") for a variety of categories including sound level, amount of visible moving water, and overall aesthetics. Flows were viewed from lowest to highest, however, the actual flow (in cubic feet per second) was not shared with the respondents. The average scores for each flow and each category are provided in Table 33.

Table 32. Average participant ratings for the aesthetic assessment demonstration flows at the Bellows Falls bypass reach for each observation point.

Demo Flow Number	Sound Level			Sound Interest			Amount of pools/ still water in channel			Amount of visible moving water in channel			Amount of exposed rocks/ streambed in channel			Contrast between pools and moving water			Amount of water through / over dam			Overall Aesthetic Rating		
Observation Point	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1 (125 cfs)	0.5	0.4	1.0	0.9	0.1	0.9	0.8	0.8	1.3	0.8	0.6	1.2	0.9	0.9	1.6	0.4	0.4	1.4	1.3	1.3	0.9	1.3	1.3	1.7
2 (1,580 cfs)	1.6	1.7	1.7	0.8	1.4	1.4	0.7	0.7	0.9	0.7	1.0	1.6	0.7	0.7	1.6	0.7	0.7	0.9	0.9	0.9	1.1	1.2	1.2	1.6
3 (2,370 cfs)	1.2	1.3	1.9	1.1	1.2	1.3	1.2	1.2	1.0	1.2	1.0	1.4	1.5	1.5	1.4	1.4	1.4	0.8	0.9	0.9	1.4	1.5	1.5	1.4
4 (3,300 cfs)	1.4	1.2	1.4	1.3	1.0	1.2	1.3	1.3	1.1	1.3	1.4	1.6	1.2	1.2	1.4	0.8	0.8	1.3	1.0	1.0	1.0	1.3	1.3	1.4
5 (4,370 cfs)	1.4	1.2	1.6	1.1	1.0	1.4	0.3	0.3	1.1	0.3	0.5	1.6	0.4	0.4	1.6	0.5	0.5	1.2	0.9	0.9	1.2	0.5	0.5	1.4
6 (5,560 cfs)	1.4	1.4	1.8	1.2	1.2	1.6	0.1	0.1	1.1	0.1	0.7	1.7	0.8	0.8	1.7	0.4	0.4	0.6	0.8	0.8	1.1	1.5	1.2	1.6

439. Overall, participants generally reported that flow higher than the leakage flow of 125 cfs in the Bellows Falls bypass reach improved aesthetics in the reach. Additionally, participants responded that observation point 3 provided the largest difference between observed flows, in terms of distinguishing difference in flow between exposed rocks, pools and riffles in the reach.

440. In its review of the initial draft study report for the aesthetic flow assessment, the Department commented that the initial report relied solely on flows released during the whitewater boating flow assessment, rather than including data from the instream flow study as proposed by the

[16] Vilas Bridge is now closed with concrete barriers in place to deter both vehicles and pedestrians access across the bridge.

Applicant.[17] The omission of the information for the aesthetic flow assessment which would have provided information on lower flows, resulted in the range of flows assessed as part of the assessment that was relatively high for evaluating compliance with the aesthetics designated use. Additionally, given the information provided, the Department concluded it may not have sufficient information to make a determination, particularly for flows between 125 cfs and 1,580 cfs. To correct the deviation, the Department requested that the Applicant collect an additional set of videos and photos at the observation points for flows between 125 cfs and 1,580 cfs.

441. The Applicant collected additional photos and videos of flows between 125 cfs to 1,600 cfs from the observation points in June 2016. The specific flows evaluated as part of the supplement were 125 cfs, 500 cfs, 1,000 cfs, and 1,600 cfs. Sound was limited at these sites due to the sound of automobiles. Additionally, supplemental photos and videos of approximately 300 cfs and 1,480 cfs taken by Agency staff during the bypass habitat-flow study were reviewed. Flows were ranked for their aesthetic value as being poor, fair, good, very good, or excellent. In addition, flows were qualitatively ranked to the previous flow as being either significantly worse, worse, same, better, or significantly better.

442. At a leakage flow of approximately 125 cfs, aesthetics were rated as fair, Comments observed some water movement and mist visible below the dam,whitewater was visible in the riffle sections in the lower bypass reach, and some visible movement of water in the pool.

443. A flow of 500 cfs was rated as good to good plus. The comments were that spray and mist from water falling along with water movement was visible below the dam. Additionally, more whitewater was visible in the riffle sections with water movement visible in the pool upstream of the railroad bridges. That flow was ranked as better to significantly better than the 125 cfs.

444. Flows of 1000 cfs and 1600 cfs were both ranked as very good plus. Both flows exhibited spray rising from below the dam with water movement downstream. The riffle areas maintained visible whitewater with a long tail out, along with continuous movement in the pool upstream of the bridges.

445. The supplemental flows taken during the habitat flow study in the bypass reach were also reviewed and ranked for their aesthetic value. Photos and videos of 300 cfs were taken from several points along the bypass reach and were rated as good. Several areas of whitewater were visible at that the riffle areas, with visible water movement in the runs and pools. This flow also produced a very good sound from the vantage point.

446. Similarly, a flow of approximately 1,450 cfs from the habitat flow study was reviewed and was rated as very good plus. Spray was visible at the base of the dam and water movement through the reach, as well as the sound was determined to be very good.

III. Analysis

447. A state's 401 certification shall "evaluate whether the activity will comply with water quality requirements." 40 C.F.R §121.3. Accordingly, the Department may set forth limitations and

[17] Vermont Department of Environmental Conservation letter to Kimberly Bose, Secretary, Federal Energy Regulatory Commission. Wilder, Bellows Falls, and Vernon Hydroelectric Project: Comments on Updated Study Reports and Request for Additional Study, May 2, 2016, 21 pp.

other requirements necessary for it to find that there is reasonable assurance that the Project will be operated in a manner which will not violate VWQS. A goal of the Standards and the Clean Water Act is to restore the biological integrity of waters such that aquatic biota and wildlife are sustained by high quality habitat.

448. Continued operation of the Project may lead to violations of Standards. Those specific aspects of operation that have the potential to cause violations of Standards are analyzed below to determine the limitations and requirements necessary to find that there is reasonable assurance that the discharge will not violate VWQS.

449. In addition to the specific items pertaining to the Application on review, if an activity was not presented in the Application and not consistent with the findings of this Certification, the Department reserves the right to review said activity to assure it will not cause a violation of VWQS (e.g., change in operation, maintenance drawdown, construction activity, etc.). In addition to specific operational conditions, other provisions like reporting, inspections, and flow monitoring will also be necessary to assure the discharge does not violate VWQS.

A. Water Chemistry

450. The Connecticut River in the vicinity of the Project is classified as Class B(2) for all designated uses and is designated as cold water fish habitat. The criteria for the dissolved oxygen (DO) standard is not less than 7 mg/L and 75 percent saturation at all times, nor less than 95 percent saturation during late egg maturation and larval development of salmonids in waters that the Secretary determines are salmonid spawning or nursery areas important to the establishment or maintenance of the fishery resource. In all other waters designated as a cold water fish habitat, the standard is not less than 6 mg/L and 70 percent saturation at all times. (Standards, Section 29A-302(5)(A)).

451. The Applicant conducted a water chemistry study in the years 2012 and 2015. For details on the methodology, see Findings 151-153. The Applicant was operating the Project as currently licensed.

452. The only occurrence of dissolved oxygen falling below the VWQS criteria of not less than 6 mg/L and 70 percent saturation were documented in the forebay during 2012, which was the result of stratification. However, DO levels recovered in the tailrace after water moved through the turbines and was discharged to the river. No occurrence of DO falling below the VWQS occurred during 2015 in the vicinity of the Project. See Findings 155-157 and Table 10.

453. Temperature within the Project area and upstream in the tributaries followed anticipated trends seen within rivers and riverine impoundments. There was typically a cyclical response to water temperatures throughout the day, with warmer temperatures occurring later in the day. This trend continued through the warm temperatures of later summer and early fall when the highest temperatures were observed. There were no temperature criteria violations of the VWQS during the study. See Finding 154.

454. Although the studies were conducted under current operations, it is anticipated that the proposed operations will reduce hydrologic alteration, which would be expected to have a positive effect on dissolved oxygen and buffer changes in temperature relative to current operations. Table 33 shows the difference between the proposed operations and current

operations for the downstream flow metrics calculated in Table 6 (Findings 76-79) and Table 9 (Findings 108-109).

Table 33. Difference in estimated downstream metrics for proposed operations verse current operations for specific seasons and water years from wettest (2009) to driest (2015).

Target Month and Year	Average Minimum downstream flow	Mean daily amplitude	Flashiness
2009			
February	611	1660	0.02
June	2205	-3520	-0.05
August	2436	-3807	-0.04
November	2140	-3548	-0.04
2016			
February	2980	-204	-0.02
June	1284	-1878	-0.07
August	801	-2428	-0.09
November	2031	-1966	-0.05
2017			
February	2912	-162	-0.02
June	1272	-1841	-0.07
August	796	-2532	-0.10
November	1907	-1810	-0.05
2015			
February	1418	-3671	0.02
June	2740	-3524	-0.03
August	1227	-5279	-0.14
November	2080	-5031	-0.10

455. Table 33 indicates that overall, there is an increase in the average minimum downstream flow, which further supports the expectation that proposed operations are likely to improve water chemistry parameters in the vicinity of the Project relative to current operations. Therefore, this certification is conditioned to incorporate the Applicants amended proposal to operate the facility in an IEO mode along with flexible and transition operations modes (Condition B).

B. Aquatic Biota

456. "Aquatic Biota" means all organisms that, as part of their natural life cycles, live in or on waters. (Standards, Section 29A-102(5)). Aquatic biota includes fish, aquatic invertebrates, amphibians, and some reptiles such as turtles. There are a wide variety of species with different life histories and requirements for protection within the Bellows Falls Project area. These include fully aquatic species, like fish, who spend their entire life cycles in the water, and organisms who do not such as turtles, beaver, and frogs.

457. The Applicant studied the potential for impingement and entrainment of resident fish species

(See Findings 167-178).

458. Adult American eel had a high overall entrainment potential. The following species and life stages had high to medium overall entrainment potential: Bluegill juveniles, Golden Shiner juveniles, Spottail Shiner adults and juveniles, Walleye juveniles, and Yellow Perch juveniles. Most of these species and life stages are categorized as such due to their size and swimming ability combined with the velocities at the intake at maximum hydraulic capacity.

459. The amount of time that the Applicant is expected to operate the Project at its maximum hydraulic capacity, which under current operations generally occurs on a near daily basis and for multiple hours would occur less frequent and for reduced durations under proposed operations. This will reduce through rack velocities and lower overall potential for fish to be entrained into the turbines.

460. This is supported by the reduction in the mean daily amplitude estimated for the proposed operations versus the current operations (Table 33). In all estimated years and months, except for February of the wettest year, 2009, it is estimated that there will be a decrease in the maximum observed downstream flows. Therefore, this certification is conditioned to incorporate the Applicant's proposal to operate the facility in an IEO mode along with the flexible and transition operations (Condition B).

461. The Applicant entered into a fish passage settlement agreement, which includes conducting studies and constructing upstream and downstream fish passage facilities for American eel; and operating the existing fishway to accommodate resident species and the full migration period for American eel (Findings 116-118). This will take place in consultation with the applicable resource agencies and utilize agreed upon methodologies. These measures will be protective of fish species with higher entrainment potential and comply with the Standards. This certification is conditioned to accept the Applicant's proposal to implement the terms of the fish passage settlement agreement (Condition E).

462. Additionally, the Applicant is proposing to install a trashrack with 2-inch clear bar spacing with an approach velocity of less than 2 fps at the proposed minimum flow turbine to pass flow to the bypass reach of the Connecticut River. This certification is being condition to accept the Applicant's proposal (Condition D).

C. Fish Passage

Upstream

463. The Applicant conducted two studies specific to upstream fish passage as part of the Project relicensing (Findings 182-190). This included collecting information specific to American eel, as well as collecting information on fish currently utilizing the upstream fish passage facility.

464. Efforts to observe congregating American eel below the Project resulted in one observation during the study (Findings 182-184). This observation occurred during the time period when the fish ladder was also operational (Study 17). Results demonstrate that American eel concentrate in the fish ladder. American eel have been observed annually passing Bellows Falls, and a total of 60 American eel passed in 2015 (study year). American eel have also been observed upstream of the. The number of eels at the Project will likely increase once an

effective upstream passage is constructed at the hydroelectric projects downstream on the Connecticut River.

465. The Applicant also reviewed video from operation of the fish ladder. Diadromous fish species that were observed using the ladder were sea lamprey (970), American eel (60), and American shad (44) (Table 14). One Atlantic salmon was also believed to have passed the Project based on an observation at the upstream Wilder hydroelectric project. For American eel, the occasions in which they were observed in the ladder varied at the facility from the current dates when the upstream passage is operated. American eel passage occurred later than the current dates.

466. Resident species were also observed using the fish ladder, demonstrated that when the upstream passage is open, it allows for resident species to move upstream as needed (Table 14).

467. The Applicant has committed to a fish passage settlement agreement that includes an upstream fish passage effectiveness study of the existing fish ladder by PIT tagging American eel and Sea Lamprey (Findings 119). The results will help to inform the installation of safe, timely, and effective fish passage measures for these species. The Applicant is also committed to investigating the need for upstream eel passage at the dam should congregation of eels below the dam in the bypassed reach be observed. The Applicant supports the removal of the Salmon dam located in the bypass reach. This certification is conditioned to incorporate the Applicant's proposal to implement and adhere to the fish passage settlement agreement (Condition E).

Downstream

468. The Applicant conducted two studies to understand downstream passage of American eel at the Project. The first included estimates of turbine mortality, as well as timely and effective passage. The second study investigated American eel migration cues specific to the Connecticut River (Findings 193-212).

469. Estimates of turbine mortality were low at the Project, with an estimated survival rate of 98 percent through the turbines. The examination of eels revealed 14 percent sustained injury passing through the turbine with 6 percent considered major. The results are similar to other studies that found American eel survival is higher for Francis type turbines, such as the units at Bellows Falls, versus Kaplan type turbines (Findings 197-201).

470. For the second component of the study, American eel that passed the Project utilized the turbines 80 percent of the time. While only 13.5 percent used or the trash/ice sluice, which is considered the downstream passage route. The higher percentage of eel using the turbines for downstream passage was consistent across all release groups (Table 15).

471. The study of downstream passage at the Project indicated there are delays, injury and some mortality. Whether it be time searching for a viable means to pass the Project or residency time within the tailrace or within the bypassed reach after passing the Project (Findings 207-212). Notably some individuals that passed through the turbines have a high residence time in the tailrace (Table 16). Some individuals did not move and were considered dead.

472. The studies at the Project indicate that there are issues with safe, timely, and effective downstream fish passage for American eel. The Applicant has proposed to implement and

adhere to the fish passage settlement agreement which includes investigating and modifying downstream passage facilities to provide safe, timely, and effective downstream fish passage. This process will take place in consultation with applicable resource agencies. This certification is conditioned to incorporate the Applicant's proposal to implement and adhere to the terms of the fish passage settlement agreement (Condition F).

473. The Applicant has proposed to install a Natal Energy Restoration Hydro Turbine with a hydraulic capacity of 300 cfs to 345 cfs to pass the 300 cfs conservation flow to the bypass reach of river. While the turbine type is thought to have a high survival rate of American eel passing through the unit, the Applicant is proposing to conduct a post-commissioning evaluation of turbine survival and injury of adult American eel to verify the hypothesis. A study plan will be developed in consultation with the state and federal fisheries agencies with the aim of conducting the study during the first downstream passage season following the commissioning of the new unit. This certification is being condition to accept the Applicant's proposal to conduct a post-commission evaluation of survival of adult American eel through the new minimum flow turbine (Condition G).

D. Aquatic Habitat

474. Waters designated as Class B(2) for aquatic habitat use shall be managed to achieve and maintain high quality aquatic habitat, characterized by the physical habitat structure, stream processes, and flow characteristics of rivers and streams and the physical character and water level of lakes and ponds necessary to protect and support all life-cycle functions of aquatic biota and wildlife, including overwintering and reproductive requirements (Standards, Section 29A-306(b)(3)(A)).

Flow Needs for the Protection of Aquatic Habitat

475. The results of the habitat-flow study indicate that there is no single flow that optimizes available habitat for all target species and lifestages within the riverine reach of the Project (Findings 249). Additionally, there is no minimum and maximum flow that optimizes remaining available habitat for all target immobile and mobile species (Findings 250-254). This is not surprising given the number of fish species of interest with varying life histories and habitat needs for depth, velocity, and substrate.

476. While there is no single flow or set of flows that will optimize habitat for all species, there are observable trends across species and life stages (Findings 250-254). The smaller the magnitude of change between the minimum and maximum flow, the greater the amount of suitable habitat that will remain available.

477. The Applicant's operations proposal seeks to reduce the magnitude and frequency of sub-daily changes in discharge from the stations, increase the amount of time that the Project is operated as IEO, and reduce the magnitude and rate of change in flows downstream of the dams. The proposal includes several measures to achieve these goals, including a maximum downstream flow during flexible operations based on inflow, a limitation on the number of hours in which flexible operations may take place, and up-ramping and down-ramping to make the transitions in flow to and from flexible operations more gradual. These measures are consistent with the findings of the habitat-flow study described above.

478. By establishing IEO as the base operating mode, minimum downstream flows are expected to increase relative to current operations when downstream flows are generally maintained around 1,200 cfs. In addition, maximum discharge during flexible operations are restricted based on inflow. When inflow is less than 1,800 cfs, maximum discharge is limited to 4,500 cfs. Above 1,800 cfs, maximum discharge is limited to 2.5 times inflow. Together, the higher baseflow associated with IEO operations and the maximum generation flow restrictions associated with flexible operations will achieve what the habitat-flow study showed is needed to protect aquatic habitat for the diverse community of species present in the Connecticut River, to reduce the magnitude of change between the baseflow and generating flow.

479. As described above, specific elements of the proposed operations are intended to reduce hydrologic alteration in a manner that protects aquatic habitat. This can be verified by using the HEC-RAS model to estimate the magnitude of fluctuations downstream of the Project under the Applicant's proposal. Table 34 shows the reduction in the daily range of flow fluctuation downstream of the Project between the proposed operations and current operations as represented by change in mean daily amplitude calculated in Table 6 (Findings 76-79) and in Table 9 (Findings 108 and 109).

Table 34. Difference in estimated downstream mean daily amplitude, expressed in cubic feet per second, metrics for proposed operations and current operations. For specific seasons and water years from wettest (2009) to driest (2015).

Target Month and Year	Change in mean daily amplitude
2009	
February	1660
June	-3520
August	-3807
November	-3548
2016	
February	-5146
June	-2492
August	-2451
November	-1966
2017	
February	-5281
June	-2452
August	-2555
November	-1810
2015	
February	-1904
June	-2557
August	-3178
November	-2245

480. Another way to consider the potential effects of the proposed operations is to calculate the difference in downstream mean daily amplitude compared to the Project operating in strict IEO mode. This would remove any Project related effects in downstream flow from flexible and

transition operations as proposed.

481. Table 35 shows the difference between the estimated IEO and proposed operations for the downstream changes in mean daily amplitude as calculated in Table 3 (Findings 58 -63) and in Table 9 (Findings 108 and 109).

Table 35. Difference in estimated downstream mean daily amplitude, expressed in cubic feet per second, metrics for estimated inflow equals outflow and proposed operations. For specific seasons and water years from wettest (2009) to driest (2015).

Target Month and Year	Change in mean daily amplitude
2009	
February	3107
June	230
August	432
November	372
2016	
February	777
June	324
August	334
November	2220
2017	
February	804
June	324
August	366
November	2220
2015	
February	4123
June	-71
August	1527
November	2672

482. There is expected to be an increase in the daily average magnitude of flows downstream of the Project relative to IEO conditions. However, this change is moderate relative to the expected hydrology of the system without the influence of the Project. In all years and seasons, the proposed operations will decrease the daily average magnitude of change in downstream flows, except in June 2015 where there was a minimal 71 cfs increase. This certification is conditioned to incorporate the Applicant's proposal to operate the facility in an IEO mode along with flexible and transition operations (Condition B).

483. For mobile species, or those species that move to find suitable habitat, the frequency of those movements can come at an energetic cost (Finding 252). For immobile species, these flow changes can involve a loss of suitable habitat,increase risk of predation and potential to become stranded. Decreasing the frequency of flow fluctuations reduces this energetic cost, risk of

predation and mortality, and is more protective of aquatic habitat.

484. The Applicant's operating proposal reduces the frequency of sub-daily changes in discharge from the dam. Under current operations, flow can fluctuate from the minimum flow to generation flow daily or multiple times a day. The principal measure for achieving this goal in the proposed operations is a limitation on the number of hours during which the Applicant can deviate from IEO and implement flexible operations. In general, during times of year when there are more sensitive species such as spawning and incubation or fry stages, the Applicant is proposing to operate in flexible operations less frequently. The specific hours for a month are driven by the habitat needs of specific species. This is discussed in more detail in the 'protection of life cycle requirements' section below. This measure will protect sensitive immobile species and life stages that are particularly sensitive to flow fluctuations. As a result of this measure, it is expected that the proposed operating regime will result in a decrease in the frequency of flow fluctuations downstream of the Project.

485. Analysis supports the expectation that the proposed operations will decrease the frequency of fluctuations downstream of the Project. Table 36 shows the difference between the proposed operations and current operations for the downstream changes in flashiness as calculated in Table 6 (Findings 76-79) and in Table 9 (Findings 108 and 109). The measure of flashiness does not have units and instead is used as a comparative measure.

Table 36. Difference in estimated downstream flashiness metric for proposed operations and current operations. For specific seasons and water years from wettest (2009) to driest (2015).

Target Month and Year	Flashiness
2009	
February	0.02
June	-0.05
August	-0.04
November	-0.04
2016	
February	-0.02
June	-0.07
August	-0.09
November	-0.05
2017	
February	-0.02
June	-0.07
August	-0.10
November	-0.05
2015	
February	0.02
June	-0.03
August	-0.14
November	-0.10

486. In all cases, except for two months where there was a slight increase, the comparison shows a decrease in the flashiness of flows downstream of the Project.

487. Flashiness can also be compared between the Project operating in a strict IEO mode and the Applicant's proposal. This would remove any Project related influence on downstream flow as the Project would only be passing what was available from inflow (Table 37).

Table 37. Difference in estimated downstream flashiness metric for proposed operations and estimated inflow equals outflow operations. For specific seasons and water years from wettest (2009) to driest (2015).

Target Month and Year	Flashiness
2009	
February	0.06
June	0.01
August	0.01
November	0.00
2016	
February	0.01
June	0.01
August	0.02
November	0.04
2017	
February	0.01
June	0.01
August	0.02
November	0.04
2015	
February	0.11
June	0.00
August	0.04
November	0.04

488. As estimated using the HEC-RAS model, there is only a slight difference in the flashiness of downstream flow below the Project between IEO mode and the Applicant's proposal.

489. In addition to the potential for changes in flow to reduce suitable habitat for immobile species and cause mobile species to move to seek suitable habitat, Finding 252 identified that the rate of change can impact available habitat due to stranding. The Applicant's proposal includes transition operations that gradually increase flows, or up-ramp, and gradually decrease flows, or down-ramp, as applicable when a planned flexible operation starts and after it ends (Findings 98-103).

490. The Applicant's proposal will reduce the magnitude of change in flow downstream, limit the

duration of deviations from IEO and reduce the frequency of flow fluctuations downstream, and provide for changes in flow to occur gradually. This certification is conditioned to accept the Applicant's proposal to operate the facility in an IEO mode along with flexible and transition operations as proposed (Condition B).

Bypass Flow

491. The management goals and objectives for the bypass reach was to prioritize the protection of the riffle habitat in the bypass, which is a rare and limited habitat type available in this section of the Connecticut River. Additionally, riffles are the most sensitive habitat type to changes in flow.

492. The Applicant, in consultation with the Department and other stakeholders, conducted a site-specific hydraulic habitat study utilizing a PHABSIM approach to determine the relationship between streamflow and available aquatic habitat (Findings 221-225).

493. In reviewing the results of the hydraulic model, it was determined at transect four flows likely did not remain perpendicular to the transect through all flows that were modeled. This resulted in the transect having a much faster rate of wetted width increase at modeled flows compared to others because the transect ran along the margin of the channel rather than up the bank. Therefore, it was determined that the data from the transect violated the assumptions of hydraulic modeling (Findings 226- 229) Given this, data from the transect was not used in the final analysis.

494. The overall management goals were to focus on protection of riffle habitat in the bypass reach. The substrate composition of the bypass was found to be mostly boulder and bedrock with limited pockets of finer substrate needed to support spawning. Thus, no spawning or fry life stages were included in the final analysis. Therefore, only species and life stages that were determined to be riffle dependent species were included in the optimization model.

495. The aquatic habitat for the species and life stages modeled did not share the same patterns as flow increases through the bypass reach. To optimize the available habitat the Department would typically take an approach to at a minimum, maintain 80 percent of the maximum habitat observed for the most limiting species and life stages. However, there is no single flow that results in providing 80 percent or more of the maximum observed habitat for all species and life stages.

496. The result of the optimization analysis indicates that there is a narrow range of flows between 150 cfs and 325 cfs that provides 80 percent of the maximum observed habitat for the most limiting species (Figure 4).

497. The Applicant is proposing to pass a conservation flow of 300 cfs through a minimum flow unit at the dam. The flow of 300 cfs falls within the range of flows that provides 80 percent of the maximum observed habitat for the most limiting species. Therefore, this certification is being conditioned to include the Applicant's proposal that a continuous flow of 300 cfs be released at the Bellows Falls dam into the bypass to protect aquatic habitat (Condition B).

Water Level Fluctuation in the Impoundment

498. The Applicant is proposing three modes of operations, IEO, flexible operations, and transition operations, which bridges changes between operating modes. Flexible operations involve water level fluctuation as the impoundment is drawn down and subsequently refilled. It is anticipated that the proposed operations will decrease fluctuations within the Bellows Falls impoundment. The following table (Table 38) shows the difference between the proposed operations and current operations for the impoundment metrics calculated in Table 5 (Findings 74 and 75) and in Table 8 (Findings 106 and 107).

Table 38. Difference in estimated impoundment metrics for proposed operations and current operations. For specific seasons and water years from wettest (2009) to driest (2015).

Target Month and Year	% time at target SWE	Mean daily change in impoundment
2009		
Feb	53.7%	-0.59
Jun	91.3%	-0.89
Aug	90.1%	-1.01
Nov	88.1%	-1.16
2016		
Feb	37.1%	-0.25
Jun	99.3%	-0.56
Aug	71.2%	-0.69
Nov	54.7%	-0.60
2017		
Feb	48.9%	-0.52
Jun	84.8%	-0.86
Aug	51.1%	-0.84
Nov	60.1%	-0.76
2015		
Feb	37.0%	-0.22
Jun	95.5%	-3.61
Aug	72.3%	-3.69
Nov	56.1%	-0.59

499. Table 38 shows that for all scenarios under the proposed operating regime, the mean daily change in the range of impoundment fluctuations will decrease. Additionally, the amount of time spent at the target surface water level increases in all months and years. Under estimated IEO operations, the percent of time at target water surface elevation would be near 100 percent, and the mean daily change in impoundment would also reflect a near 0 foot elevation change in elevation. There would be measurable differences between estimated IEO operations and the Applicant's proposal.

500. In addition to limiting the frequency and magnitude of impoundment fluctuations, the Applicant is proposing to refill the impoundment within 48 hours of a flexible operation event (Finding 101). This is expected to decrease the rate at which the water level changes after a

drawdown.

501. Maintenance activities, in particular those that require a drawdown, have the potential to impact water quality standards depending on the duration, extent, and season during which the drawdown may occur. The Applicant is proposing to suspend IEO operations when necessary for performing maintenance. In addition, the Applicant proposes to consult with relevant resource agencies before such deviations which may include an appropriate impoundment refill plan (Finding 93).

502. The Applicant's proposal will create more stable impoundment levels and when fluctuations occur, it will be in a manner that is protective of aquatic habitat and complies with the hydrology criteria of the Standards. Accordingly, this certification is conditioned to incorporate the Applicant's proposal to operate the facility in an IEO mode along with flexible and transition operations (Condition B), and to consult on maintenance activities that require deviation from IEO operations.

Stream Processes and Physical Habitat Structure

503. Stream processes are defined as the hydrologic, bed-load sediment, and large woody debris regimes of a particular stream reach and is a term used to describe stream channel hydraulics, or the erosion, deposition, sorting, and distribution of instream materials by the power of flowing water. Stream processes work toward an equilibrium condition, are governed by flow characteristics, stream morphology, channel roughness, and floodplain connectivity and, in part, determine physical habitat structure and aquatic habitat quality (Standards Section 29A-102 (43)).

504. Physical habitat structure is defined as the diverse combination and complexity of instream forms created within substrate and woody debris on and within the bed and banks of the channel by stream processes and flow characteristics. Physical habitat structure, in part, determines aquatic habitat quality at the stream reach and stream network scales by providing for all life cycle functions, which include the full set of forms necessary for the provision of and access to cover, overwintering, and temperature refuge and the substrates necessary for feeding and reproduction of aquatic biota and wildlife (Standards, Section 29A-102 (34)).

505. Stream processes, including erosion, are a naturally occurring and an ongoing process in river systems, particularly in response to changes to work toward an equilibrium condition. The Connecticut River has historically been straightened and continues to be confined within a narrow corridor in part due to armoring and berming. This historic manipulation continues to affect how the Connecticut River and its sediment regime responds during flow events. The lack of connectivity and access to the floodplains results in the river having increased power to move sediment and scour banks within the channel. Due to these historic changes that are not related to the Project, the river is likely to remain contained to the narrow corridor and disconnected from the floodplain. In this condition, it is likely that the Connecticut River will continue to adjust to try to achieve equilibrium condition, which is likely to continue to lead to increased scour within the channel than what would be expected in an equilibrium state where the sediment and hydrologic regimes were in balance.

506. There are many other contributing factors to erosion, some are natural and some are not. These factors include the type of soil, the shape of the channel, natural seeps, and Project operations,

which are the subject of this certification. However, it is not possible to determine which of those is the primary cause of a particular erosion event.

507. The data collected in study 1 – 3 analyzed historic erosion from aerial photos and conducted an on the ground two-year study measuring bank movement. While there was noteworthy bank movement within the Bellows Falls impoundment between 1953 to 1975 the rate of erosion was determined to have decreased by about 50 percent between 1975 to 2010 when compared to the earlier aerial photos series.

508. The two-year field study observed erosion in both the Bellows Falls impoundment and downstream of the facility in the Bellows Falls riverine reach. Most of the erosion observed occurred at elevations higher than the normal Project operations, however, notching and sediment deposition or removal at the toe of the banks was observed at the median elevation of current Project operations for some sites.

509. Using the HEC-RAS model developed by the Applicant, additional analysis can be completed by reviewing the nodal data throughout the impoundment. This can provide data on the difference between the minimum and maximum surface water elevation changes under an IEO mode and under the proposed Project operations (Table 17, Table 18 and Findings 281-284).

510. Using the methods described above, the calculated differences in estimated magnitudes between proposed operations and IEO mode are provided in Table 39. The data indicates that the maximum change in water surface elevation between proposed operations and IEO is 1.22 feet during the wet year, with the minimum difference being 0.0 feet.

Table 39. The table includes the calculated difference in estimated change in water surface elevation between proposed operations and inflow equals outflow mode. Each node represents a transect from the Bellows Falls dam (smaller nodal numbers) to the upper portion of the impoundment (larger nodal numbers). The years are representative of various hydrological years ranging from wet to dry. The months (February (Feb), June, August (Aug), and November (Nov)) are representative of different seasons and numbers of flexible hours.

Year	Month	Node 515	Node 540	Node 565	Node 590	Node 615	Node 640	Node 665	Node 690
2009	Feb	0.36	0.39	0.37	0.40	0.40	0.33	0.79	1.22
	June	0.10	0.10	0.10	0.10	0.11	0.10	0.12	0.11
	Aug	0.08	0.08	0.07	0.07	0.03	0.03	0.02	0.02
	Nov	0.05	0.05	0.05	0.05	0.05	0.09	0.15	0.32
2015	Feb	0.46	0.46	0.41	0.44	0.31	0.39	0.49	0.79
	June	0.05	0.05	0.04	0.02	0.00	-0.02	-0.03	-0.10
	Aug	0.17	0.17	0.16	0.15	0.13	0.13	0.13	0.16
	Nov	0.34	0.33	0.31	0.32	0.28	0.30	0.39	0.66
2016	Feb	0.24	0.24	0.23	0.24	0.23	0.26	0.31	0.46
	June	0.10	0.10	0.09	0.09	0.06	0.04	0.04	-0.01
	Aug	0.15	0.16	0.15	0.15	0.13	0.14	0.16	0.25

	Nov	0.36	0.37	0.34	0.35	0.32	0.36	0.45	0.84
2017	Feb	0.40	0.41	0.37	0.39	0.34	0.42	0.61	1.05
	June	0.08	0.08	0.09	0.09	0.10	0.11	0.12	0.12
	Aug	0.22	0.22	0.21	0.20	0.17	0.16	0.18	0.32
	Nov	0.23	0.24	0.22	0.25	0.22	0.31	0.45	0.74

511. The Applicant's proposal includes measures to reduce impoundment fluctuations by operating in an IEO outflow mode along with flexible and transition operations. This certification is conditioned to incorporate the Applicant's proposal to operate the facility in an IEO mode along with flexible and transition operations (Condition B).

Protection and Support of Life Cycle Functions

512. The Applicant conducted a study in 2015 that investigated the effects of current operations on spring spawning fish within the Project area including in backwaters, near islands, and near the mouths of tributaries (Findings 285-305). Several nests were observed and assessed in the study. Table 40 is a subset of the reported data noting the percentage of days where water levels were below the median height of the nests as estimated for different water years. Although the height at which a fish spawns is influenced by the water year and conditions within the impoundment, for the study analysis it was assumed that in other years as estimated, those locations did not vary.

Table 40. Estimates of the average number of days the water surface elevation would be expected to fall below the median height of nests or spawning areas for various water years representing the driest to wettest. The locations are all from the Bellows Falls Project area and include backwaters, islands, and tributaries. Each value varies depending on the species of interest.

Species	Yellow Perch	Sunfish	Fallfish		Smallmouth Bass	
Reach/habitat types	Bellows Falls Backwater	Bellows Falls Backwater	Bellows Falls Tributaries	Bellows Falls Islands	Bellows Falls Tributaries	Bellows Falls Islands
1992 Driest year	0%	22%	0%	0%	7%	34%
1989	4%	17%	0%	0%	6%	22%
1994 Average Year	5%	2%	0%	0%	0%	31%
2007	3%	23%	0%	0%	6%	29%
1990 Wettest Year	0%	4%	0%	0%	5%	15%

513. The above table indicates that under current operations, nests of Smallmouth Bass and Sunfish could potentially be affected. The Applicant's proposed operations will reduce the potential of

project effects during the more biologically sensitive times of year for aquatic species and life stages. For example, the Applicant's proposal is to limit flexible operation to no more than 10 hours each month, April through June to limit the potential effects on spring migrants and resident spawning species.

514. Analysis of the effects of the Applicant's proposal on the water levels of the impoundment (Table 38) shows that for the month of June, which is representative of spring conditions, the time at which the Bellows Falls impoundment will remain at or near the target surface water elevation increases a minimum of 84.8 percent to a maximum of 99.3 percent across the modeled years. The magnitude of the impoundment fluctuations will also decrease by 1.48 feet on average for the June period of the modeled years.

515. In addition, Table 17 and Table 18 (with a focus only on June) indicates that changes in water surface elevation throughout the impoundment will vary only slightly under the Applicant's proposal. Therefore, this certification is being conditioned to incorporate the Applicant's proposal to operate in an IEO mode with flexible and transition operations (Condition B).

Sea Lamprey Spawning

516. Sea Lamprey prefer shallow areas with fast moving water with gravel and cobble substrate to construct nests for spawning. In the sea lamprey spawning study, the potential for nests or habitat to be dewatered was noted at two sites in the impounded reach and two sites in the riverine reach of the Project affected waters. The study and subsequent modeling indicated that under current operations dewatering of habitat or nests could occur. The dewatering of a nest affects survival and the life cycle and functions of Sea Lamprey spawning activities within the Bellows Falls Project affected waters.

517. The Applicant is proposing to change operations to operate in an IEO mode with flexible and transition operations. Analysis of the impoundment and water level fluctuations related to Project affects in June of the modeled years indicated that water level fluctuation in the impoundment will be more stable (Table 39) under the Applicant's proposal. Additionally, the proposal will reduce the amplitude (Table 36) and the flashiness (Table 38) of flows downstream of the Project. These operational changes will reduce Project related effects on the sea lamprey and support spawning.

E. Wildlife and Wetlands

518. The Applicant has historically operated the Project in a daily peaking mode, but now proposes to reduce the frequency and magnitude of peaking operations. The number of hours during which flexible operations would be permitted would vary depending on the season. The Applicant's proposal will limit the frequency of water fluctuations as described in findings 85-88. These operations will create a more stable environment for wetlands and wildlife in the next license term (Table 38).

519. Specifically for wetlands, the maximum number of hours in which water level fluctuations may occur is in the winter months, when most wetland vegetation will be dormant because it is outside of the growing season. During the growing season, particularly in the early season as plants typically emerge, the Applicant will be permitted to fluctuate water levels less frequently, and therefore wetlands and wildlife will experience less hydrologic alteration.

520. The Applicant's proposal will be protective of the wetlands and wildlife within the Project area. Accordingly, this certification is conditioned to incorporate the Applicant's proposal to operate the facility in an IEO mode along with flexible and transition operations (Condition B).

F. Rare, Threatened, and Endangered Species

521. The studies conducted by the Applicant concluded that there were no occurrence of either Fowlers toad, nor Northeastern bulrush within the Project area, so they are not further discussed as part of this certification.

Northern Long-eared Bat

522. The Northern long-eared bat is listed at both the state and federal level as endangered (Table 22). There are no known occurrences in the Project area. The Applicant has not indicated a need for tree clearing activities. To avoid impacts to potential hibernacula, if tree clearing is needed, it is recommended that it be limited to the winter season for trees that are 3-inches in diameter at breast height or larger. As such, the Agency is conditioning this certification to include a limitation of the timeframe under which tree clearing activities can occur for trees that are three inches in diameter at breast height or larger (Condition G).

523. Should the Applicant need to cut trees that are three inches in diameter at breast height or larger outside of the allowed timeframe, the Applicant shall first consult with the Vermont Fish and Wildlife Department and the U.S. Fish and Wildlife Service.

Dwarf wedgemussel

524. Dwarf wedgemussel (*Alasmidonta heterodon*) is state and federally listed as endangered. Known occurrences of dwarf wedgemussel occur within the Bellows Falls impoundment.

525. There are a number of opportunities to decrease the risk associated with Project operations for the protection of DWM habitat. This includes reducing the fluctuations within the impoundment to limit dewatering (Finding 334). Reducing the dewatering of mussels within the impoundment, particularly during the winter season, would limit potential for mussels to freeze (Finding 336).

526. The Applicant's proposal reduces the frequency and magnitude of flow fluctuations downstream and the associated water level fluctuations of the impoundment by operating in an IEO mode, along with flexible and transition operations. The Application also specifically includes lowering the impoundment level before the winter to facilitate successful overwintering of DWM.

527. Accordingly, this certification is conditioned to incorporate the Applicant's proposal to operate the facility in an IEO mode along with flexible and transition operations (Condition B).

Dragonfly and Damselfly

528. Seven of Vermont's Species of Greatest Conservation Need (SGCN) dragonflies and damselflies (odonates) occur within the Wilder, Bellows Falls, and Vernon project affected area.

529. Of the seven odonates, four were located within the Bellows Falls project affected area. These included *Gomphus abbreviates, Gomphus vastus, Stylurus amnicola*, and *Stylurus scudderi.* All these species were observed at multiple transects within the Bellows Falls riverine or impoundment reaches.

530. Within the Bellows Falls project affected area, a total of 237 Odonate observations were made. No observation of teneral or eclosure phase were made during the study. There were 14 observations of larvae emerging during the study. The distance from the waterline for the emergence phase for individuals was between 4 inches to 33 inches with an average of 13 inches. For the exuvia observations, ranged from 0 inches to 72 inches with an average of 24 inches above the waterline. It should be noted that it is possible that some exuvia could have been located at lower water elevations and then been inundated or swept from the bank when water levels rose.

531. The Applicant's proposal will reduce the frequency and magnitude of flow fluctuations downstream by operating in an IEO mode, along with flexible and transition operations. These operations will create periods of stable water level for odonates larvae to complete the eclosion process.

532. Accordingly, this certification is conditioned to incorporate the Applicant's proposal to operate the facility in an IEO mode along with flexible and transition operations (Condition B).

Cobblestone and Puritan Tiger Beetles

533. Puritan tiger beetles (*Cicindela puritana*) are state and federally listed as threatened, while cobblestone tiger beetles (*Cicindela marginipennis)* are state-listed as threatened. CTB were located within the Project area at three locations: Chase Island, Walpole Island, and Ascutney Riverbank (Findings 365-368).

534. Limiting the frequency and magnitude of flow fluctuations at the sites where CTB are located will benefit the species by avoiding inundation and facilitating successful reproduction. Using a model developed by the Applicant, the difference between water surface elevation at those locations relative to operating in an IEO mode can be evaluated.

535. The table below is the difference in water surface elevation changes at selected nodes within the Bellows Fall Project area where CTB were located (Table 41). The table is the difference between Table 23 and Table 24 which represents different modeled operating modes (Findings 367 and 368).

Table 41. The difference in estimated water surface elevation changes between two operating modes (inflow equals outflow or proposed operations) at three locations within the Bellows Fall Project area where Cobblestone Tiger Beetles were located.

Year	Month	Chase Island Node 709	Ascutney Riverbank Node 671	Walpole Island Node 448
2009	June	0.1	0.2	0.1
	Aug	0.1	0.0	0.1
2015	June	-0.1	-0.1	0.0
	Aug	0.1	0.1	0.6

2016	June	0.0	-0.1	0.1
	Aug	0.2	0.2	0.1
2017	June	0.1	0.1	0.0
	Aug	0.3	0.2	0.6

536. In nearly all modeled cases, the difference between average daily elevation change is minimal as simulated through different types of water years for the active months of the CTB.

537. Additionally, a memorandum of understanding agreed to by the Applicant provides an opportunity to meet with the Agency to discuss potential corrective actions should the management goal not be met. This goal involves maintaining multiple consecutive day periods, numbering 3 or greater, where operations do not exceed flow thresholds that maintain 75 percent or greater uninundated habitat for most sites during the CTB active period.

538. The hydrologic change associated with proposed operations will not exceed moderate differences from operations without artificial flow changes and will protect the reproduction of the CTB. Accordingly, the Agency is incorporating the Applicant's proposal to operate in an IEO mode along with flexible and transition operating modes (Condition B).

Shortnose Sturgeon

539. Shortnose sturgeon are state and federally listed as endangered. The presence of shortnose sturgeon in the reach of the Connecticut River below the Project was recently documented from video, photos, and a positive detection from environmental DNA sampling.

540. The NMFS is the federal agency with jurisdiction over the research, conservation and management needs for protection and recovery of the shortnose sturgeon. Currently, there is little to no information on the population of sturgeon in this reach of the Connecticut River or whether spawning is occurring. However, it is believed the based on the eDNA study results that the population is smaller than the population in the lower reach of the Connecticut River below Turners Falls. NMFS is working with partners to better understand the population of sturgeon in this reach of the Connecticut River and any potential conservation or management measures needed to protect them.

541. At this time there is no information to suggest that the Applicant's proposal is not protective of the observed shortnose sturgeon. Should NMFS determine that additional measures are needed that conflict with the condition of this Certification, the Applicant will need to request an amendment to the Certification, as applicable.

G. Recreation

542. The VWQS require that waters achieve and maintain good quality that fully support boating, fishing, and other designated recreational uses. (Standards, Section 29A-306(d)(3)(A); Standards, Section 29A-306(e)(3)(A); and Standards, Section 29A-306(f)(3)(A)).

543. The Applicant conducted a study that included in-person surveys, surveys mailed to residents in the region and a recreational inventory including both Applicant-owned facilities and other facilities located within the Project affected area. The Applicant included questions on safety,

adequacy of the recreational facilities, and the types of uses enjoyed. Lastly, the study addresses the current capacity of the recreational facilities and their future adequacy (Findings 382-400).

544. Comments provided in the 2014-2015 recreational surveys relating to recreational use were also provided to the FERC record (Finding 400).

545. The recreational surveys documented that the majority of individuals rated the recreational facilities as scenically average to extremely appealing, and safe to extremely safe (Table 25). While most respondents indicated they were satisfied with the recreational facilities, some offered suggestions for improving the facilities, such as improving boat ramps, bathrooms and trash disposal facilities.

546. A notable exception was the Charlestown boat launch and picnic area where individuals expressed dissatisfaction due to the boat launch being unusable. The Applicant closed the boat launch area shortly after the survey to address the concerns expressed. The issues at the boat launch were addressed by the Applicant during the relicensing period and the Charlestown boat launch was reopened in 2018.

547. Additional comments in the FERC record are that the Applicant should fund projects to mitigate the economic and recreational impacts of the Project, develop a takeout and portage on the Vermont side of the river, add additional facilities to access the river. These activities are outside the scope of the water quality certification, which is limited to water quality related impacts of the activity.

548. The existing recreation facilities provide public access to public waters. The Applicant also proposes specific enhancements to recreation facilities at the Project (Findings 132 and 133). The Applicant also proposes to maintain and enhance various recreational areas as needed and develop a recreational management plan after license issuance (Finding 132). Additionally, the Applicant has proposed to provide a shuttle service for paddlers portaging around the project.

549. This certification is conditioned to incorporate the Applicant's proposal to enhance and maintain specific recreational facilities and develop a recreational management plan that includes consultation with relevant stakeholders who have a direct interest in the facilities at the Project (Condition I).

Boating

550. For waters classified as B(2) for the boating designated use, the management objective is to maintain a level of water quality compatible with good quality boating. The criteria to meet this objective is the applicable hydrology criteria. The Department has not adopted any subcategories of the designated use of recreational boating.

551. The Applicant's proposal to operate in an IEO mode with flexible and transition operations will limit impoundment and downstream flow fluctuation and create a more stable impoundment with higher downstream flows. Additionally, the Applicant has proposed to maintain the online and phone system to provide users of the river access to current and scheduled flow information for the Project. These operational changes will support recreational boating in both the impoundment and downstream reach below the Project.

552. The Bellows Falls bypass reach is a 0.7-mile-long reach of the Connecticut River that is bypassed by the Project. Currently, there are no scheduled whitewater releases into the Bellows Falls bypass reach. Additionally, access to the reach is limited on the Vermont side as most of the abutting property is an active railyard not owned by the Applicant.

553. The Applicant conducted a whitewater boating study specific to the Bellow Falls bypass (Findings 411-422 and Table 27-Table 31). The paddlers who participated in the study self-identified as advanced to expert boaters and had either a canoe or kayak for the study.

554. From the whitewater study, the minimum flows for whitewater boating in the Bellows Falls bypass differed by boating type. Participants using canoes indicated a minimum flow of 1,500 cfs was needed where kayakers stating a minimum of approximately 2,000 cfs was needed in the bypass for whitewater boating (Finding 420). Both boating types identified a flow of approximately 2,300 as a preferred flow (Finding 421).

555. The Applicant is not proposing to provide access to the Bellows Falls bypass reach due to high flow danger concerns and the lack of suitable and safe ingress and egress to the reach for users and public safety officials. The Applicant is proposing to release a continuous flow of at least 300 cfs. Higher flows in the bypass will occur when the flow is over the hydraulic capacity of the Project.

556. While boating in the bypass at the lower proposed conservation flow of 300 cfs was not directly assessed, the boatability of the bypass under the proposal can be evaluated using existing information for flatwater canoeing or kayaking. By using the existing information in the record on the depth and width of the Bellows Falls bypass at various flows collected at the transects through the reach (Finding 425) and comparing this information to the criteria to define a boatable channel (Finding 427) the boatablity of the channel can be ascertained.

557. Based on this information it is determined that the bypass reach would support boating at a flow of at least 300 cfs. This certification is being conditioned to accept the Applicant's proposal (Condition B).

558. However, as stated above, boating has not been permitted or encouraged in the Bellows Falls bypass reach due to high flow danger concerns and the lack of suitable ingress and egress into the reach. Public access to the bypass reach is an obstacle to formal boating opportunities. While there are informal trails, typically down steep embankments, these typically cross privately owned land or are adjacent to roads and railroad property. On the Vermont side of the river, the land adjacent to the bypass reach is owned by the railroad and access would require crossing active train tracks which could create a public safety issue.

H. Debris

559. The Applicant described to some degree how the Project-related debris is disposed. Some organic debris is directed downstream via the sluiceway in the forebay area, while other debris is pulled up with a hydraulic rack rake and moved to a trailer for disposal (Findings 428-430). The information presented in the application does not include enough specificity as to how debris is managed. This certification is conditioned (Condition K) to assure that debris disposal is consistent with applicable regulations (Finding 11).

I. Aesthetics

560. Aesthetics is a designated use of the Standards. The management objective for waters classified as Class B(2) for aesthetics is "waters shall be managed to achieve and maintain good aesthetic quality" (Standards, Section 29A-306(c)(3)(A)). The Class B(2) criteria for aesthetics use in rivers and streams are "water character, flows, water level, bed and channel characteristics, and flowing and falling water of good aesthetic value." (Standards, Section 29A-306(c)(3)(B)(i)).

561. The Applicant is proposing to operate in an IEO mode along with flexible and transition operations. The proposed operations will decrease the frequency and extent to which the impoundment is lowered (Table 39 and Table 40).

562. The Project bypass a 0.7-mile reach of the river. As part of the relicensing, the Applicant conducted an aesthetic flow study in the bypass reach of river. Based on the results of the study, a flow of at least 300 cfs is necessary to provide good aesthetic value in the bypass reach. Therefore, the Applicant's proposal to provide a flow of 300 cfs to the bypass reach will support the aesthetics use (Finding 441-444).

563. Based on the Applicant's proposal, the hydrologic change associated with the proposed operations will be limited to moderate differences from natural condition below the Project which will provide good aesthetic value in the Connecticut River in the Project affected area.

564. Accordingly, this certification is conditioned to incorporate the Applicant's proposal to operate the facility in an IEO mode with flexible and transition operations and with a conservation flow of at least 300 cfs to the bypass reach (Condition B).

J. Antidegradation

565. Pursuant to the Anti-Degradation Policy set forth in the Standards (Section 29A-105) and the Agency's 2010 Interim Anti-Degradation Implementation Procedure (Procedure), the Secretary must determine whether proposed discharges or activities are consistent with the Policy by applying the Procedure during the review of applications for any permit for a new discharge if, during the application review process, compliance with the Standards is evaluated pursuant to applicable state or federal law. (Procedure, Section III(A)). This includes water quality certifications required by Section 401 of the federal Clean Water Act for a federal license or permit for flow modifying activities. (Procedure, Section III(B)(3)).

566. In making a determination that proposed activities are consistent with the Anti-Degradation Policy and Implementation Procedure, the Secretary is required to use all credible and relevant information and the best professional judgement of Agency staff. (Procedure, Section III(D)). Section VIII of the Procedure governs the Agency's review of Section 401 applications for flow modifying activities. (Procedure, Section VIII(A)(1)). The Secretary may have to review a single waterbody under multiple tiers of review depending on whether a waterbody is impaired or high quality for certain parameters.

567. Tier 3 review is required if the project will discharge to an Outstanding Resource Water. (Procedure, Section VIII(D)). This Project does not affect any Outstanding Resource Waters and therefore does not trigger a Tier 3 review under Section VIII of the Procedure.

568. This Project affects waters classified as B(2) for all designated uses and criteria, which are presumed to be high quality waters for certain parameters that triggers a Tier 2 review under Section VIII of the Procedure. (Procedure, Section VIII(E)(1)(c)). Under Tier 2, the Secretary

must determine whether the proposed discharge will result in a limited reduction in water quality of a high quality water by utilizing all credible and relevant information and the best professional judgment of Agency staff. (Procedure, Section VIII(E)(2)(b)).

569. When conducting a Tier 2 review, the Secretary may consider, when appropriate, any of the following factors when determining if a proposed new discharge will result in a reduction in water quality: (i) the predicted change, if any, in ambient water quality criteria at the appropriate critical conditions; (ii) whether there is a change in total pollutant loadings; (iii) whether there is a reduction in available assimilative capacity; (iv) the nature, persistence and potential effects of the pollutant; (v) the ratio of stream flow to discharge flow (dilution ratio); (vi) the duration of discharge; (vii) whether there are impacts to aquatic biota or habitat that are capable of being detected in the applicable receiving water; (viii) the existing physical, chemical and biological data for the receiving water; (ix) degree of hydrologic or sediment regime modifications; and (x) any other flow modifications. (Procedure, Section VIII(E)(2)(d)).

570. The Secretary considered the foregoing factors during the review of the Project to determine if the Project will result in a reduction of water quality in the waters affected. The principal impacts of the Project are in the reaches of the Connecticut River affected by the Project and consist of flow and water level management associated with Project operations and the resulting effects on aquatic biota and wildlife, and aquatic habitat. The changes in operation of the Bellows Falls Hydroelectric Project will not result in a discharge of additional pollutants or reduce other ambient water quality criteria. As a result, factors (i), (ii), (iii), (iv), (v), and (vi) are not at issue. Conditions B and C of this certification, which prescribe flow and water level management regimes and monitoring requirements, are expected to maintain or improve aquatic habitat conditions and reduce the degree of hydrologic alteration associated with operation and maintenance of the facility.

571. This certification does not authorize any activities that would result in a reduction of water quality for those parameters that exceed Standards.

572. For those parameters for which project waters do not exceed Standards, the Secretary must conduct a Tier 1 review. (Procedure, Section VIII(F)).

573. When conducting a Tier 1 review, the Secretary may identify existing uses and determine the conditions necessary to protect and maintain these uses. (Procedure, Section VIII(F)). In determining the existing uses to be protected and maintained, the Secretary must consider the following factors: (a) aquatic biota and wildlife that utilize or are present in the waters; (b) habitat that supports existing aquatic biota, wildlife, or plant life; (c) the use of the waters for recreation and fishing; (d) the use of the water for water supply, or commercial activity that depends directly on the preservation of an existing high level of water quality; and (e) evidence of the ecological significance of the use in the functioning of the ecosystem or evidence of the rarity of the use. (Procedure, Section VIII(F)(2)).

574. The Secretary considered the foregoing factors pertinent to a Tier 1 review of the Project and, based on information supplied by the Applicant and Agency staff field investigations, identified the following existing uses in the reaches of the Connecticut River affected by the Project: aquatic biota and wildlife; aquatic habitat; recreation; and aesthetics.

575. The existing dam and impoundment have changed the natural condition of the river at the

Project location. Currently, aquatic biota and wildlife, aquatic habitat, recreation – boating, and aesthetics are impacted in the Connecticut River by water level fluctuations within in the impoundment, by insufficient conservation flow in the bypass reach, and by insufficient base flow conditions and high generation flows downstream of the Project. The Applicant is proposing to operate the Project in an IEO mode by maintaining a target water elevation at the dam with limited discretionary flexible operations as a condition of this certification. The conditions of this certification were developed to reduce the frequency and magnitude of impoundment fluctuations, reduce the magnitude and rate of change in flows downstream and overall to reduce the hydrologic alteration associated with operations of the Project. In addition, the Applicant is proposing to continuously pass a conservation flow to the bypass reach. The analysis demonstrates the conditions of the certification will fully support the existing uses identified in Finding 573.

576. The Secretary finds that the operation of the Project, as conditioned by this certification, will comply with the VWQS and other applicable rules. Accordingly, the Secretary finds that the Project, as conditioned, meets the requirements of the Policy and Procedure relating to the protection, maintenance, and improvement of water quality.

IV. Decision and Certification

The Department has examined the Project application and other pertinent information deemed relevant by the Department to issue a decision on this certification application pursuant to the Department's responsibilities under Section 401 of the federal Clean Water Act and 10 V.S.A. § 1253(h). After examination of these materials, the Department certifies that there is reasonable assurance that operation of the Project, in accordance with the following conditions, will not violate the Standards; will not have a significant impact on use of the affected waters by aquatic biota, fish or wildlife, including their growth, reproduction, and habitat; will not impair the viability of the existing populations; will not result in a significant degradation of any use of the waters for recreation, fishing, water supply or commercial enterprises that depend directly on the existing level of water quality; and will be in compliance with sections 301, 302, 303, 306, and 307 of the federal Clean Water Act, 33 U.S.C. section 1341, and other appropriate requirements of state law:

A. Compliance with Conditions. The Applicant shall operate and maintain the Project consistent with the findings and conditions of this certification. The Applicant shall not make any changes to the Project or its operations that would have a significant or material effect on the findings, conclusions, or conditions of this Certification without approval of the Department.

See finding 449 for a statement of necessity. 10 V.S.A. § 1258 & Vt. Code R. 12 030 026 § 29A-101.

B. Flow Management. The Project shall be operated in an inflow equal to outflow (IEO) operation by maintaining a stable target water level at the dam of 291.1 feet (+/- 0.5 feet), except when lowered during DWM pre-winter habitat protection operations (See below). Outflows shall be adjusted based on calculated inflow at least on an hourly basis. When inflow exceeds project capacity, all flow shall be passed via a combination of spillage and discharge through the powerhouse. Inflow equals outflows operations are permitted to be suspended during operation modes included in Table 2. A continuous flow of at least 300 cfs shall be passed downstream of the dam into the bypass reach at all times, regardless of whether the Project is operating in an IEO, Flexible, or Transition Operations as defined below.

Flexible Operations: At the discretion of the Applicant, Project operations may deviate from IEO operations to a mode using storage to generate, known as flexible operations. Flexible operations shall not exceed the maximum allowable hours specified in Table 1 below. There are no limitations on the number of flexible operations events per day or the duration of the event.

During flexible operations, the water surface elevation of the impoundment shall be between 289.6 and 291.1 feet between October 1 to May 31, and between 290.1 to 291.1 feet from June 1 to September 30. The maximum discharge during flexible operations will be based on the calculated inflow at the hour in which the flexible operations occur. When the calculated flow is 1,800 cfs or less, the maximum discharge is 4,500 cfs. If the calculated inflow is greater than 1,800 cfs, the maximum discharge shall be no greater than 2.5 times the calculated inflow at the hour which the flexible operations begin.

Table 1. The monthly allocation of hours for flexible operations at the Bellow Falls Hydroelectric Project.

Month	Hours
December through March	No more than 65 hours each month
April through June	No more than 10 hours each month
July	No more than 20 hours with no more than 10 hours between July 1 – 15.
August through October	No more than 20 hours each month
November	No more than 42 hours with no more than 10 hours between November 1 - 15

Transition Operations: Transition operations are the required operations needed to transition to and from IEO to a flexible operation event. Transition operations include requirements for up-ramping, down-ramping and refill. Table 2 below specifies the applicability of transition operations for various Project operations.

Up-ramping: Up-ramping is required for scheduled flexible operation events. During up-ramping flow will begin to increase over the hour preceding to the flexible operations event hours. The up-ramping rate for the Project shall be the lesser of 1 cubic feet per second per square mile of drainage area (approximately 5,414 cfs) or the flow halfway between the IEO flow and the flexible operations flow.

Down-ramping: Down-ramping shall occur after a flexible operations event where flow is decreased until the flow is equal to inflow at the dam. Decreases in flow shall occur on an hourly basis as a percentage of previous hours flow. The first hour after a flexible operation event, flows shall be no greater than approximately 70 percent of the flexible operations flow. Each successive hour flow will be approximately 70 percent of the previous hour.

Refill: The impoundment shall be restored to the target water level elevation of 291.1 feet within 48-hour period subsequent to post-flexible operation down ramping completion. Refill shall occur by retaining a percentage of inflow to restore the impoundment elevation. The hourly flow rate below the Project will be the greater of approximately 70 percent of inflow or the seasonal minimum base flows.

The 48-hour refill period begins immediately after the down-ramping after a flexible operations event and ends no more than 48-hours later unless the reservoir is within 0.1 ft. of the target water surface elevation of 291.1 feet. The 48-hour period includes any temporary interruptions during the refill period.

Table 2: Operation modes of the Bellows Falls Hydroelectric Project and the applicability of transition operations components to each operations mode.

Operations Mode	Up- Ramping	Down- Ramping	Impoundment Refill
Flexible Operations, Scheduled	Applied during the hour prior	Applied as Defined	Applied as Defined
Flexible Operations, Un-	Not Applied	Applied as Defined	Applied as

Scheduled			Defined
High Water Operations	Not Applied	Not Applied	Not Applied
CCA and RPD audits	Not Applied	Applied as Defined	Applied as Defined
Emergencies and System Emergencies	Not Applied	Not Applied	Not Applied

Dwarf Wedgemussel Pre-Winter Habitat Operations: The water surface elevation as measured at the dam, shall be lowered to an elevation at or above the low limit of the flexible operation range of the impoundment and maintained for a limited period of time when water temperatures are consistently dropping from 15°C to 10°C, typically occurring in late-October to early-November. Once the water temperature is consistently below 10°C the water surface elevation can be returned to the target elevation of 291.1 feet and the elevation range above the lower limit can be utilized for flexible operations. The water surface elevation shall remain above the DWM pre-winter habitat protection elevation throughout the winter period until March 1st unless inflows required Project to flood profile operations.

See findings 85-108, 456-517, 524-527, 542-558, and 560-564 and 146 for a statement of necessity. 10 V.S.A. § 1258 & Vt. Code R. 12 030 026 § 29A-304 & § 29A-306 (b)(3)(B) & § 306 (d)(3).

C. Minimum Base Flows. Minimum base flows are required to be maintained below the Project at all times. The minimum base flow is the combination of flow below the dam and the powerhouse. The seasonal minimum base flows for the project are 3,000 cfs from April 1 through May 31; 1,400 cfs from June 1 through September 30; 1,600 cfs from October 1 through March 31; and the 300 cfs flow in the bypass reach of the Connecticut River year-round. Flow below the Project shall be equal or greater than the seasonal minimum flow unless the calculated inflow is less during IEO operations.

See findings 85-108, 456-517, 542-558, and 560-564 for a statement of necessity. 10 V.S.A. § 1258 & Vt. Code R. 12 030 026 § 29A-304 & § 29A-306 (b)(3)(B) & § 306 (d)(3).

D. Construction and Installation of the Minimum Flow Turbine. The Applicant shall construct the proposed minimum flow turbine with trashracks with 2-inch clear spacing. If activies associated with the construction and the installation of the minimum flow turbine result in a deviation from the conditions of this Cerification, the Applicant shall consult with the Department prior to starting the work.

See findings 127-132, 447-449, and 462 for statement of necessity. 0 V.S.A. § 1258 & Vt. Code R. 12 030 026 and § § 29A-304(d) and 29A-306(b)(3)(A)

E. Operations Compliance and Monitoring Plan. The Applicant shall develop, within 180 days of the effective date of the FERC license, an operations compliance and monitoring plan detailing how the Project will operate in compliance with IEO operations, Flexible Operations, and Transition Operations. The plan shall also include when the Project is being operated in response to emergency and system operations requirements. The plan will also include a method for continuous monitoring and reporting outflow releases (e.g. spillage and turbine discharge) at the Project, impoundment levels, and inflow. The plan shall include provisions for the operations data to be submitted to the Department.

The plan will include procedures for reporting deviations from prescribed operating conditions to the Department. Reports shall be made within 15 days after a deviation and will include, if possible, the cause, severity, and duration of the deviation, observed or reported adverse environmental impacts from the incident, pertinent data, and measures to be taken to avoid recurrences.

The plan will include procedures for reporting deviations from prescribed operating conditions to the Department. Reports shall be made within 15 days after a deviation and will include, if possible, the cause, severity, and duration of the deviation, observed or reported adverse environmental impacts from the incident, pertinent data, and measures to be taken to avoid recurrences.

The plan shall be subject to Department approval. The Department reserves the right to review and approve any material changes made to the plan.

See finding 449 for a statement of necessity. 10 V.S.A. § 1258 & Vt. Code R. 12 030 026 § 29A-304 & § 29A-306(b).

F. Fish Passage. Upstream and downstream fish passage measures shall be implemented under the terms and conditions within the Settlement Agreement for Fish Passage[18] (Agreement) which are summarized in Findings 113 – 125 and available in Appendix A. The Applicant shall develop a Fish Passage Management Plan (FPMP), in consultation with the Vermont Fish and Wildlife Department and other signatories to the Agreement, and submit to FERC within 120 days of the effective date of the FERC license. The FPMP shall specify the implementation schedules as calendar dates and will identify anticipated subsequent, supplemental fish passage filings to the FERC that may be required depending on the scope of the element to be implemented. The FPMP shall identify all anticipated consultation with the Vermont Fish and Wildlife Department and other signatories to the Agreement in development of the pre-design analysis, design, and effectiveness evaluation, as appropriate.

As required by the Agreement, the required fish passage operational periods are as follows for the Project. The upstream fish passage measures shall be operated April 1 - July 15 upon issuance of the FERC license. [19] Upstream American eel passage shall be provided from May 1 to November 15 upon completion of the implementation of enhancements as set forth in the Agreement. The downstream fish passage shall be operated from August 1 – December 1 upon completion of the implementation of enhancements as set forth in the Agreement. The Applicant shall support the removal of the barrier dam located in the bypass channel.

See finding 110-126 and 463-472 for a statement of necessity. 10 V.S.A. § 1258 & Vt. Code R. 12 030 026 § 29A-306(b)(3)(A).

G. Minimum Flow Turbine American Eel Survival Rate. The Applicant shall conduct a post-commissioning evaluation of the new minimum flow turbine at the Bellow Falls dam for the

[18] Great River Hydro, LLC Settlement Agreement for Fish Passage; Vernon, Bellows Falls, and Wilder Hydroelectric Projects dated August 2, 2022.

[19] The April 1 start date is to accommodate early spring spawners such as walleye and white suckers only. The fish ladder at Bellows Falls shall commence operation as close as possible to April 1 annually, but no later than April 15 as long as ice conditions and/or debris conditions allow for fish ladder inspections and the ladders are fully operational.

rate of survival and injury of adult American eel that pass through the unit. The study plan shall be developed in consultation with and approved by state and federal fisheries agencies prior to completing construction of the unit. If the results of the study indicate an issue with survival of American eel passing through the units, the Applicant shall consult with the Department and fisheries agencies to determine how the issue shall be addressed.

See findings 127-132, 447-449, 462, and 473 for a statement of necessity. 10 V.S.A. § 1258 & Vt. Code R. 12 030 026 § 29A-306(b)(3)(A).

H. Northern Long-eared Bat Protection. The Applicant shall avoid tree trimming and removal of trees 3- inch diameter breast height or greater in the project boundary between April 1st and October 31st to avoid any roost disruption of the Northern long-eared bat, except when necessary to protect public safety or respond to emergency conditions. In case of a public safety issue or emergency where tree trimming or removal are required during the seasonal protective period, the Applicant will consult with the Department as soon as practical after conducting the trimming or removal.

See finding 332, 334, and 522 for a statement of necessity. 10 V.S.A. § 5403.

I. Recreation. In accordance with the Applicant's proposal, within one year of the effective date of the FERC license, the licensee shall develop a recreation management plan providing additional details on the schedule for implementing the Applicant's recreation proposal summarized in Findings 133 and 134. The proposal includes at Harricks Cove recreation site to improve the dock, parking area, and picnic sites; expand car top launches; and bird observation platform and trails. At the Pine Street boat launch the proposal is to improve the boat launch, parking area, and picnic sites; repair and re-purpose red barn for portage support; and to provide a portage transportation service around the Project. At the Charlestown recreation site the proposal includes improving parking area and picnic sites, and finish remaining improvements to the boat launch for tailered boats. Other recreation proposals include enhancements to the Visitor Center and improvements and rehabilitation of the canoe camp site. Additionally, the Applicant is proposing to maintain its online and phone system to provided users of the river with streamflow information and scheduled generation from the Project. The plan shall also include the frequency at which recreational sites for which the Applicant has agreed to maintain will be checked for maintenance needs. The plan shall be developed in consultation with the Department. The plan shall be subject to review and approval from the Department.

See finding 85-137 and 542-558 for a statement of necessity. 10 V.S.A. § 1258 & Vt. Code R. 12 030 026 §29A- 303(d-f).

J. Public Access. The Applicant shall allow public access to the project lands for utilization of public resources, subject to reasonable safety and liability limitations. Such access should be prominently and permanently posted so that its availability is visible to the public. In instances that access limitations are necessary to prevent unreasonable risks to public safety or in the case where an immediate threat to public safety exists, the Applicant may restrict access. In such instances where access is restricted due to public safety issues, the Applicant shall notify the Department.

See finding 85-137 for a statement of necessity. 10 V.S.A. § 1421

K. Debris Disposal. Debris associated with Project operations shall be disposed of in accordance with the Standards and applicable state laws and regulations.

See findings 429-431, and 559 for a statement of necessity. 10 V.S.A. § 1258 & Vt. Code R. 12 030 026 § 29A-303(1).

L. Maintenance and Repair Work. The Applicant shall consult with the Department prior to conducting Project maintenance or repair work that necessitates a deviation from the conditions that assure compliance with water quality requirements (e.g., water level or flow management). Such maintenance and repair work shall be subject to review and approval by the Department.

See findings 88, 93, 321, 449, 501, and 502 for a statement of necessity. 10 V.S.A § 1258 & Vt. Code R. 12 0330 026 § 29A-304(d) and § 29A-306(b).

M. Compliance Inspection by Department. The Applicant shall allow the Department to inspect the Project area at any time to monitor compliance with certification conditions.

See findings 2 and 449 for a statement of necessity. 10 V.S.A § 1258 & Vt. Code R. 12 0330 026 § 29A-104.

N. Posting of Certification. A copy of the certification shall be prominently posted within the Project powerhouse.

See findings 2 and 449 for a statement of necessity. 10 V.S.A § 1258 & Vt. Code R. 12 0330 026 § 29A-104(b).

O. Modification of Certification. The conditions of this certification may be altered or amended by the Department to assure compliance with the Vermont Water Quality Standards and to respond to any changes in classification of management objectives for the waters affected by the Project, when authorized by law, and, if necessary, after notice and opportunity for hearing.

See findings 2 and 447-449 for a statement of necessity. 10 V.S.A § 1258 & Vt. Code R. 12 0330 026 § 29A-104(a)(c).

Effective Date and Expiration of Certification

This certification shall become effective on the date of issuance, and the conditions of any certification shall become conditions of the federal permit (33 U.S.C. § 1341(d)). If the federal authority denies a permit, the certification becomes null and void. Otherwise, the certification runs for the terms of the federal license or permit.

Enforcement

Upon receipt of information that water quality standards are being violated as a consequence of the Project's construction or operation or that one or more certification conditions has not been complied with, the Secretary, after consultation with the Applicant and notification of the appropriate federal permitting agency, may, after notice and opportunity for a public hearing, modify the Certification and provide a copy of such modification to the Applicant and the federal permitting agency.

Certification conditions are subject to enforcement mechanisms available to the federal agency issuing the license and to the state of Vermont. Other mechanisms under Vermont state law may also be used to correct or prevent adverse water quality impacts from construction or operation of activities for which certification has been issued.

Appeals

Pursuant to 10 V.S.A. Chapter 220, any appeal of this decision must be filed with the clerk of the Environmental Division of the Superior Court within 30 days of the date of the decision. Pursuant to 10 V.S.A. Chapter 220, an aggrieved person shall not appeal this decision unless the person submitted to the Secretary a written comment during the applicable public comment period or an oral comment at the public meeting conducted by the Secretary. Absent a determination of the Environmental judge to the contrary, an aggrieved person may only appeal issues related to the person's comments to the Secretary as prescribed by 10 V.S.A. § 8504(d)(2). The Notice of Appeal must specify the parties taking the appeal and the statutory provision under which each party claims party status; must designate the act or decision appealed from; must name the Environmental Division; and must be signed by the appellant or their attorney. In addition, the appeal must give the address or location and description of the property, project, or facility with which the appeal is concerned and the name of the Applicant or any permit involved in the appeal. The appellant must also serve a copy of the Notice of Appeal in accordance with Rule 5(b)(4)(B) of the Vermont Rules for Environmental Court Proceedings. For further information, see the Vermont Rules for Environmental Court Proceedings, available online at www.vermontjudiciary.org. The address for the Environmental Division is 32 Cherry Street, 2nd Floor, Suite 303; Burlington, VT 05401 (Tel. 802.951.1740).

Dated this ____day of MONTH, 2025

Jason Batchelder, Commissioner
Vermont Department of Environmental Conservation

By _____
Peter LaFlamme, Director
Watershed Management Division

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

	)	**Project No. 1892-___**
Great River Hydro, LLC	)	**Project No. 1855-___**
	)	**Project No. 1904-___**

SETTLEMENT AGREEMENT FOR FISH PASSAGE

GREAT RIVER HYDRO, LLC

SETTLEMENT AGREEMENT FOR FISH PASSAGE
VERNON, BELLOWS FALLS, AND WILDER HYDROELECTRIC PROJECTS

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SETTLEMENT AGREEMENT FOR FISH PASSAGE

VERNON, BELLOWS FALLS, AND WILDER HYDROELECTRIC PROJECTS

INTRODUCTION

THIS SETTLEMENT AGREEMENT (Agreement), effective as of the date of the last signature affixed hereto (the Effective Date), is made and entered into by and between Great River Hydro, LLC, a Delaware limited liability company (Licensee); the United States Department of the Interior (DOI) Fish & Wildlife Service (USFWS); the New Hampshire Fish and Game Department (NHFG); and the Vermont Fish and Wildlife Department (VFWD) (each, a Party and collectively, the Parties).

This Agreement relates to the Vernon Project (FERC Project No. 1904), Bellows Falls Project (FERC Project No. 1855), and Wilder Project (FERC Project No. 1892) (collectively, the Projects), which are the subject of ongoing relicensing proceedings before the Federal Energy Regulatory Commission (FERC or Commission) for new licenses to operate the Projects (New Licenses). Specifically, this Agreement resolves all issues related to upstream and downstream fish passage for Targeted Migrants at the Projects under the New Licenses.

1 GENERAL TERMS

1.1 Term of the Agreement

This Agreement shall remain in effect, in accordance with its terms, throughout the term of the New Licenses, including any annual licenses thereafter.

1.2 Purpose and Goals

The purpose of this Agreement is to resolve among the Parties the appropriate prescriptions for fish passage pursuant to section 18 of the Federal Power Act (FPA) (16 U.S.C. § 811) and the Parties' recommended terms and conditions related to fish passage for Targeted Migrants under sections 10(a) and 10(j) of the FPA (16 U.S.C. §§ 803(e) and (j)), to be incorporated into the New Licenses for the Projects.[1]

[1] The Parties to this Agreement, along with the New Hampshire Department of Environmental Services and the Vermont Department of Environmental Conservation, also have executed a Memorandum of Understanding (MOU), dated as of December 1, 2020, governing proposed operational measures for the Projects under the New Licenses. Nothing in this Agreement is intended to modify the understanding of the Parties under the MOU.

1.3 Parties to Support Terms

The Parties agree to support the issuance of New Licenses by FERC and Water Quality Certifications pursuant to Section 401 of the Clean Water Act (CWA) (33 U.S.C. § 1341) by the New Hampshire Department of Environmental Services (NHDES) and the Vermont Department of Environmental Conservation (VDEC) that are consistent with the terms of this Agreement. For those matters addressed herein, specifically the passage of American shad, American eel, and sea lamprey, the Parties agree not to propose or otherwise communicate to FERC or any other federal or state resource agency with jurisdiction directly related to the current relicensing processes any comments, certification, or license conditions that would be materially additive to, or materially inconsistent with, the terms of this Agreement. However, this Agreement shall not be interpreted to restrict any Party's participation or comments regarding other matters that are not the subject matter of this Agreement, future proceedings regarding the Projects, or compliance with the terms and conditions of the Project Licenses or this Agreement.

1.4 Terms and Definitions

The Parties agree that the following terms shall be defined as follows:

- Agencies: Collective term used to refer to the United States Department of the Interior (DOI) Fish & Wildlife Service (USFWS); the New Hampshire Fish and Game Department (NHFG); and the Vermont Fish and Wildlife Department (VFWD).

- Date of License Issuance (DOLI): The date of FERC issuance of the New License. Implementation schedules outlined in this Agreement are stated by Month/Day within a specified calendar year following the DOLI.

- License Year: Full calendar years counted after DOLI. License Year 1 starts January 1 following DOLI.

- Licensee: Great River Hydro, LLC, or its successor or assigns. Great River Hydro, LLC is a Delaware limited liability company.

- New License: The new license issued by the Commission for a specified Project.

- Projects: The Vernon Hydroelectric Project (FERC Project No. 1904), the Bellows Falls Hydroelectric Project (FERC Project No. 1855), and the Wilder Hydroelectric Project (FERC Project No. 1892).

- Targeted Migrants: American shad, *Alosa sapidissima* (Vernon only);[2] sea lamprey, *Petromyzon marinus*; and American eel, *Anguilla rostrata*.

1.5 Successors and Assigns

This Agreement shall be binding upon and shall inure to the benefit of the Parties hereto and their respective successors and assigns.

1.6 Agency Appropriations

Nothing in this Agreement shall be construed as obligating any federal, state, or local government to expend in any fiscal year any sum in excess of appropriations made by Congress, state legislatures, or local legislatures, or administratively allocated for the purpose of this Agreement for the fiscal year; or as involving the DOI, USFWS, NHFG, or VFWD in any contract or obligation for the future expenditure of money in excess of such appropriations or allocations.

1.7 Establishes No Precedents

The Parties have entered into the negotiations and discussions leading to this Agreement with the explicit understanding that the discussions leading up to and resulting in the Agreement are privileged, shall not prejudice the position of any Party or entity that took part in such discussions and negotiations, and are not to be otherwise used in any manner in connection with these or any other proceedings. The Parties understand and agree that this Agreement establishes no principles or precedents with regard to any issue addressed herein or with regard to any Party's participation in future relicensing proceedings and that none of the Parties to this Agreement will cite this Agreement or its approval by FERC, the USFWS, NHFG, or VFWD as establishing any such principles or precedents. This Section 1.7 shall survive any termination of this Agreement. Any Party withdrawing from this Agreement pursuant to Section 1.14 will continue to be bound by this Section 1.7.

1.8 Filing of Settlement Agreement

The Parties agree that within thirty 30 days of the Effective Date, the Licensee shall file this Agreement, together with an Explanatory Statement, with the Commission pursuant to 18 C.F.R. § 385.602 in the dockets for the Projects' relicensing proceedings.

[2] While blueback herring (BBH) are not present in the vicinity of the Projects at this time, the Agencies are managing for the restoration of this species in the Connecticut River Basin and specific passage and protection measures for BBH may be needed in the future.

1.9 Filing of Preliminary Prescriptions for Projects

The USFWS shall file preliminary prescriptions in the relicensing proceedings for the Projects that are fully consistent with the terms of this Agreement within 60 days after the deadline established by FERC in its "Ready for Environmental Analysis and Soliciting Preliminary Prescriptions" notice under 18 C.F.R. § 5.22.

1.10 Trial-Type Hearing Requests and Alternatives

The Parties agree that if the USFWS files preliminary prescriptions for the relicensing proceedings with FERC that are fully consistent with this Agreement, neither the Licensee, nor any Party to this Agreement will file a request for trial-type hearing of issues of disputed fact pursuant to 16 U.S.C. § 811 or alternative prescriptions pursuant to 16 U.S.C. § 823d(b) with respect to those preliminary prescriptions.

The Licensee expressly reserves the right to challenge a new or amended fish passage prescription made by USFWS under any reservation of authority included in its final prescriptions for the Projects.

1.11 Filing of Final Prescriptions for Projects

If no party to the FERC relicensing proceedings files a request for trial-type hearing on disputed issues of material fact pursuant to 16 U.S.C. § 811 or alternative prescriptions pursuant to 16 U.S.C. § 823d(b) with respect to USFWS's preliminary prescriptions, and no fact is otherwise submitted to the record before the USFWS or the Commission that would make the preliminary prescription inconsistent with the administrative record, USFWS will file final prescriptions with FERC that are fully consistent with the terms of this Agreement within 60 days after the deadline for filing comments on FERC's draft NEPA document under 18 C.F.R. § 5.25(d), consistent with 43 C.F.R. § 45.73(a). If a party to the relicensing proceedings files a request for trial-type hearing or alternative prescription and USFWS issues a final prescription that is inconsistent with the terms of this Agreement, the Licensee may withdraw from this Agreement pursuant to Section 1.14 and reserves all right to challenge the modified prescription before FERC or the U.S. Court of Appeals.

1.12 Support For Water Quality Certifications for Projects

The Parties agree that they will support the NHDES and VDEC's issuance of Section 401 Water Quality Certifications to the extent that they include fish passage provisions not materially inconsistent with the provisions of this Agreement. The Licensee reserves its right to challenge the Water Quality Certifications with respect to conditions incorporated therein that are materially additive to or materially inconsistent with this Agreement or unrelated to fish passage.

1.13 Filing and Support of Settlement Provisions as Recommended Terms and Conditions

The fish passage provisions included in this Agreement constitute the Parties' complete and final recommended terms and conditions for fish passage to be included in the New Licenses through the relicensing proceedings. The Parties reserve their right to take any position before FERC with regard to terms and conditions unrelated to fish passage that may be proposed for inclusion in the New Licenses.

1.14 Withdrawal Rights

No Party may withdraw from this Agreement without the prior written consent of the other Parties, which consent may be withheld in another Party's sole discretion; provided, however, a Party may unilaterally withdraw from this Agreement if: (i) USFWS issues a final prescription that is materially additive to, or materially inconsistent with the terms of this Agreement; (ii) NHDES or VDEC issues a Water Quality Certification that contains fish passage conditions that are materially additive to, or materially inconsistent with, the terms of this Agreement and the Water Quality Certification is not thereafter satisfactorily modified after administrative and judicial appeals are pursued by the Licensee; (iii) any Party recommends terms and conditions for the New Licenses under sections 10(a) and 10(j) of the FPA that are materially additive to, or materially inconsistent with, the terms of this Agreement with regard to the matters addressed herein; or (iv) FERC issues New Licenses that contain fish passage conditions which are materially additive to, or materially inconsistent with, the terms of this Agreement, and the New Licenses are not thereafter satisfactorily modified as a result of the filing of a request for rehearing as provided in Section 1.15.

A Party withdrawing from this Agreement shall provide twenty (20) days' prior written notice, which notice shall include a written explanation of the reasons for withdrawing from this Agreement. In the event that a Party withdraws from this Agreement pursuant to this Section 1.14, this Agreement shall thereafter be null and void, and any Party may take the position that this Agreement is not available to support FERC's public interest determination.

1.15 Rehearing and Judicial Review of FERC License

The Parties agree not to file a request with FERC for rehearing of the New Licenses concerning matters addressed in this Agreement unless: (i) the New Licenses contain fish passage conditions that are materially inconsistent with the terms of this Agreement, including inconsistent timelines for studies and the operation of fish passage facilities; or (ii) the New Licenses contain fish passage conditions that are materially additive to the terms of the Agreement. In the event a Party files a request for rehearing in accordance with the terms of this provision, it will provide the other Parties written notice of its intention to file a request for rehearing at the earliest practicable time. Any Party, following the issuance of a FERC order on rehearing, may elect to

file a petition for judicial review with respect to the matters covered by this provision, and the other Parties will not oppose such petition.

1.16 Counterparts

This Agreement may be executed in any number of counterparts, all of which taken together shall constitute one and the same instrument.

1.17 Notice

If practicable, all required notices will be provided by e-mail or comparable electronic messaging agreed to by all Parties. Notice will also be sent to all Parties by first-class mail or comparable method of distribution, and as applicable will be filed with FERC. For the purposes of this Agreement, and unless otherwise specified, notice (including notice via e-mail) will be effective upon receipt, but if provided only by U.S. Mail, seven (7) days after the date on which it is mailed.

For the purpose of notice, the list of authorized representatives of the Parties is attached as Appendix C. The Parties will provide notice of any change in the authorized representatives designated in Appendix C, and the Licensee will maintain the current distribution list of such representatives. The Parties acknowledge their responsibility to keep the other Parties informed of their current address, telephone, and e-mail information. Notice obligations under this Section 1.17 are in addition to any notice provisions required by applicable law.

2 GENERAL AGREEMENTS OF THE PARTIES

2.1 Reservation of Authority to Prescribe Fish Passage Measures

The Parties agree that in order to allow for the timely implementation of fish passage, including effectiveness measures, the DOI will propose to reserve its authority to prescribe fishways by requesting that FERC include the following condition in any new license(s) it may issue for the Projects:

"Pursuant to Section 18 of the Federal Power Act, the Secretary of the Interior herein exercises their authority under said Act by reserving that authority to prescribe fishways during the term of the License and by prescribing the fishways described in the Department of Interior's Prescription for Fishways for the Projects."

2.2 Reopeners

The Parties agree that, except as provided herein, this Agreement is not intended to limit or restrict the ability of any Party to petition FERC pursuant to any reopener condition contained in the New Licenses, including but not limited to any exercise by the Secretary of the DOI relating to her/his fishway prescription authority under section 18 of the FPA that is reserved in the New License.

No such petition may be filed which would, if granted, be materially inconsistent with this Agreement, or cause other portions of the Agreement to be reopened, unless the Party who files the petition can demonstrate with substantial evidence that a change in circumstances has occurred which provides good cause for the filing of the petition. Unless in the case of the exercise of section 18 authority, which shall be processed under procedures established by the applicable statutes and regulations, no such petition may be filed without the filer providing at least sixty (60) days written notice of its intention to do so to all the other Parties. Within thirty (30) days following the giving of notice, the Parties shall in good faith consult with the other Parties regarding the need for and the purpose of the petition. Consultation requires at least one meeting of the Parties, which may be completed electronically (e.g., virtually, via telephone, etc.) or in-person in order to accommodate the schedule/availability of the Parties. In the event such a petition is filed, the filing Party shall include with its filing documentation of its consultation with the other Parties and a summary of recommendations and responses to those recommendations. The filing Party shall also serve a copy of its petition to all the other Parties via the Commission's electronic service system. The Parties are free to take any position before the Commission on such a petition.

2.3 License Amendments and Modifications

The Parties agree that, except as provided herein, nothing in this Agreement is intended to limit or restrict the ability of the Licensee to seek amendments of the New Licenses. The Licensee may only seek a license amendment or other modification to the New Licenses that would be materially inconsistent with the provisions of this Agreement if it has substantial evidence that a change in circumstances has occurred that provides good cause for the filing of the amendment or modification and has provided the Parties at least 60 days' written notice of its intention to do so and, promptly following the notice, has consulted with the Parties regarding the need for and the purpose of the amendment or modification. For other license amendments or modifications that only relate to, but would not alter the license conditions set forth in this Agreement, the Licensee shall provide all Parties at least 30 days' notice of the proposed amendment or modification and, upon any Party's request, shall consult with the Parties regarding the amendment or modification and defer the filing for another 30 days. In any application for an amendment or modification that relates to any term or condition of this Agreement, the Licensee shall document its consultation, summarize the positions and recommendations of the Parties,

and provide its response to those positions and recommendations. The Licensee shall serve a copy of any application for amendment or modification to the Parties at the time of the filing. The Licensee will not oppose an intervention request filed in a timely manner by any Party in an amendment or modification proceeding involving the New Licenses.

2.4 Agreement Amendments

No amendment to this Agreement shall be effective unless reduced to writing and signed by the Parties.

2.5 Support for Removal of Salmon Dam

The Licensee shall support and facilitate third party efforts to remove the Salmon Dam in the Bellows Falls bypass reach but in no event shall be responsible for financing removal efforts.

3 FISH PASSAGE MEASURES THE PARTIES AGREE SHOULD BE INCORPORATED INTO THE TERMS OF THE NEW LICENSES

3.1 General fish passage obligations of Licensee

The Licensee shall operate the Projects to provide safe, timely, and effective passage for Targeted Migrants, pursuant to the measures and implementation schedules detailed in subsections 3.1.1 through and including 3.8 below, and as summarized in Tables 3.4.1-1 through 3.6.2-1 (Appendix A of this Agreement) and as depicted in the Project Specific Fish Passage Implementation Chart (Appendix B of this Agreement).[3] Upstream and downstream passage systems may include physical facilities, spillage plans, reasonable operational modifications, or new (USFWS-approved) technologies as they become available. The schedules provided under this section are stated in terms of License Years based on the DOLI. They do not preclude the Licensee from proactively addressing any element on an expedited timeframe.

For all identified fish passage measures, the first year of operation shall be a shakedown year[4] followed by two years of representative quantitative effectiveness studies. Additional study years may be required in order to achieve two full representative passage seasons. A representative passage season is one where there are no anomalous[5] environmental or operational conditions, or incomplete data (e.g., due to equipment malfunction). Additional study years also may be warranted in response to any fish passage/project modifications made. A single

[3] In case of inadvertent conflict between Tables in Appendix A or the Gannt Chart in Appendix B and the narrative under Section 3, the narrative under Section 3 shall control.
[4] Shakedown refers to assessing whether all components of the fish passage facility are operating as designed.
[5] Anomalous conditions are those outside the bounds of the 25th to 75th percentile conditions for a given parameter.

representative study year may suffice should results clearly suggest measures are effective, as agreed to in writing by the Agencies.

The Parties may, by mutual written agreement, modify any time limit to implement the identified fish passage measures, if there is good and substantial reason for the modification. The Parties acknowledge that modifications to time limits under the New Licenses may require FERC approval. Delay in completing one element shall not be justification for a delay in subsequent elements.

The Licensee will develop Fish Passage Management Plans (FPMP) for each of the Projects, in consultation with the Agencies, and will submit each to the Commission for approval within approximately 120 days of the DOLI. The FPMPs will specify the implementation schedules as calendar dates and will identify anticipated subsequent, supplemental fish passage filings to the FERC that may be required dependent upon the scope of the element to be implemented. The FPMP will identify all anticipated consultation with the Agencies in the development of pre-design analyses, design, and effectiveness evaluations, as appropriate. The proposed implementation schedule and deadlines for actions under this Agreement will be discussed further with the Agencies, with timelines/schedules being advanced, where feasible, in light of the actual DOLI, particularly if the DOLI occurs between January 1 and March 31.

Table 3-1. Required fish passage operational periods.

Project	**Direction**	**Dates**	**Beginning**
Vernon	Upstream	April 1[a] – July 15	Upon New License issuance
		April 1[a] – November 15	Upon completion and implementation of enhancements (including interim eel passage)
	Downstream	April 7[b] – December 1	Upon New License issuance
Bellows Falls	Upstream	April 1[a] – July 15	Upon New License issuance
		April 1[a] – November 15	Upon completion and implementation of enhancements (including interim eel passage)
	Downstream	August 1 – December 1	Upon New License issuance
Wilder	Upstream	April 1[a] – July 15	Upon New License issuance
	Downstream	August 1 – December 1	Upon completion and implementation of enhancements

a. The April 1 start date is to accommodate early spring spawners such as walleye and white suckers only. The fish ladders at Vernon, Bellows Falls, and Wilder shall commence operation as close as possible to April 1 annually, but no later than April 15 as long as ice conditions and/or debris conditions allow for fish ladder inspections and the ladders are fully operational.
b. Downstream passage at Vernon is to be operational for Spring American Shad migration and shall commence operation as close as possible to April 7 annually, but no later than April 15 concurrent with the start of upstream American Shad migration season through the Vernon fishway.

3.2. Study Plan Review

For all study plans under this Agreement, the Licensee shall consult with and reach agreement with the Agencies, addressing their comments and concerns, on study plan design on a schedule that allows sufficient time to procure equipment, materials, etc. necessary to conduct the study during the specified study period. The Licensee shall provide the Agencies with draft study, survey, and assessment plans associated with provisions under Section 3 (e.g., hydraulic study, Passive Integrated Transponder (PIT) studies, eel surveys, etc.) and provide a minimum of 30 days for review and comment.

3.3. Fish Passage Design Review

For all provisions under subsections 3.4 through 3.6, design of passage facilities shall occur in consultation with, and require approval by, the Agencies and shall meet USFWS Design Criteria (USFWS 2019, or as modified) to the extent practicable from an engineering perspective. The Licensee shall provide plan sets for review and comment to the Agencies at the 30%, 60%, and 90% level.

3.4 Fish Passage and Protection Measures at the Vernon Project

The Licensee shall design, construct, operate, maintain, and evaluate the effectiveness of fish passage and protection facilities for Targeted Migrants at the Vernon Project.

3.4.1 Downstream Passage and Protection

The Licensee shall undertake a hydraulic study or a suitable alternative, designed to inform downstream passage/design options. The study plan shall be developed in consultation with the Agencies and shall be initiated no later than January 1 of License Year 2; the study initiated, completed and reported on no later than December 31 of License Year 3. The Licensee will use results of the study to develop design alternatives to provide safe, timely, and effective passage for Targeted Migrants. The Licensee shall initiate design consultation with the Agencies no later than July 1 of License Year 3, and final design plans (sufficient for construction bid purposes) shall be completed no later than December 31 of License Year 4. Construction shall be initiated during License Year 5 and completed no later than December 31 of License Year 6. Approved structural facilities and/or operational measures shall be fully operational no later than April 7 of License Year 7.

Specific passage/protection and effectiveness study requirements and their associated implementation schedules and operational periods are provided in Table 3.4.1-1.

3.4.2 Upstream American Eel and Sea Lamprey Passage

3.4.2.1 Within Ladder Measures for Eel and Lamprey Passage for the period April 7 through July 15

The Licensee shall undertake a hydraulic study within the existing Vernon fish ladder together with an engineering assessment of the ladder to inform potential modifications for improved effectiveness for passage of American eel and sea lamprey (this is the same hydraulic study and engineering assessment discussed under section 3.2.3). The objectives of the hydraulic study are to determine the hydraulic conditions of the fish ladder and identify hydraulic related barriers to effective eel and sea lamprey ladder passage. The engineering assessment will evaluate the condition of current as-built fish ladder components. The Licensee shall initiate consultation with the Agencies on the hydraulic study design and scope of engineering assessment no later than November 15 of License Year 2. The Licensee shall initiate the study no later than July 16 of License Year 3 and complete and report on the study no later than December 31 of License Year 4.

During the License Year 5 upstream anadromous passage season, the Licensee shall undertake studies, using PIT technology to assess passage performance of American eel and sea lamprey within the Vernon fish ladder. Consultation with the Agencies on the PIT study design will be initiated no later than July 1 of License Year 3; and the study will be initiated no later than May 1 and completed and reported on no later than December 31 of License Year 4. Should the Agencies deem results of the study insufficient to determine where passage impediments occur within the Vernon ladder, the study design will be modified through consultation with the Agencies (e.g., additional PIT antennas deployed or moved to different locations) and an additional year of study will take place in License Year 5.

The Licensee will use results of the hydraulic and PIT studies to develop design alternatives to improve eel and lamprey passage through the ladder during the period April 7 through July 15. The Licensee shall initiate design consultation with the Agencies in Year 4 and final design plans (sufficient for construction bid purposes) shall be completed no later than July 15 of License Year 5. Approved eel/lamprey ladder modifications shall be initiated starting on July 16 of License Year 5 and completed no later than April 6 of License Year 6 and be fully operational no later than April 7 of License Year 6. These dates associated with initiating design consultation with the Agencies, finalizing design plans, final design approvals by the Agencies, and date of commencing operation shall be extended 1 year if an additional year of PIT study is necessary.

3.4.2.2 Within Ladder Interim Measures for Eels for the period July 16 through November 15

The Licensee shall design, construct, operate, and maintain interim (possibly temporary) measures approved by the Agencies to pass American eels for the July 16 to November 15 period. The interim upstream eel passage facility shall consist of an eel ramp-trap, or similar design, as specified in USFWS Design Criteria (USFWS 2019). The eel ramp-trap will be located below the station, potentially within or near the entrance to the existing fish ladder at a location to be determined in consultation with the Agencies. The Licensee shall initiate design consultation with the Agencies for interim upstream eel passage facilities no later than January 1 of License Year 2, and final design plans shall be completed no later than December 31 of License Year 2. Construction of approved interim upstream eel passage facilities shall be completed by July 15 of License Year 3 and shall be fully operational no later than July 16 of License Year 3. Interim eel passage facilities shall be operated annually until permanent upstream eel passage facilities are operational. The first two years of interim passage operation will include monitoring and reporting eel use and upstream passage. Based on the results of the monitoring, if the interim measure does not appear to pass eels in anticipated and consistent numbers, the Licensee will consult and reach agreement with the Agencies on the need for further monitoring and/or adjustment to the interim measure (e.g., location or design).

3.4.2.3 Permanent Upstream Eel Passage Measures for the period July 16 through November 15

Based on the PIT and hydraulic studies required pursuant to Section 3.4.2.1, ladder monitoring results, and upstream interim eel passage data, the Licensee shall consult with the Agencies no later than July 1 of License Year 9 to determine whether existing information is sufficient to identify permanent upstream eel passage measures for the period July 16 through November 15 (i.e., via the interim means, alternate permanent ramps or via the fish ladder), or if additional studies are needed.

Should the Agencies determine additional studies are not warranted, the Licensee shall select, subject to approval by the Agencies, the preferred method of upstream permanent passage no later than January 31 of License Year 10. The Licensee shall initiate design consultation for permanent upstream eel passage facilities with the Agencies no later than February 1 of License Year 10, and the Licensee shall complete final design plans no later than December 31 of License Year 10. Construction of permanent upstream eel passage facilities approved by the Agencies shall be completed such that they are fully operational no later than July 16 of License Year 11. Agencies acknowledge the 6.5 month construction window may be negatively impacted or delayed by weather and river conditions or ability to procure materials.

Should the Agencies determine additional studies are warranted, the Licensee shall undertake them in License Year 10. Consultation with the Agencies on the additional study design will be initiated promptly following notification of additional study requirement and no later than February 15 of License Year 10, with the study initiated, completed, and reported on no later than December 31 of License Year 10. Based on study results, the Licensee shall decide on an Agency-approved preferred method of upstream permanent passage no later than January 31 of License Year 11. The Licensee shall initiate design consultation with the Agencies for permanent upstream eel passage facilities no later than February 1 of License Year 11, and complete final design plans no later than December 31 of License Year 11. Construction of permanent upstream eel passage facilities approved by the Agencies shall be completed such that they are fully operational no later than July 16 of License Year 12. Parties acknowledge the 6.5 month window to construct may be negatively impacted by weather and river conditions or ability to procure materials.

Specific passage and protection requirements and their associated implementation schedules and operational periods are provided in Table 3.4.2-1.

3.4.3 Upstream Anadromous Fish Passage

No later than July 16 of License Year 7, the Licensee shall assess if the physical configuration of the collection gallery below the powerhouse could trap American shad. If trapping conditions exist, the Licensee shall identify a solution in consultation with, and requiring approval by, the Agencies. The approved solution shall be fully implemented no later than April 7 of License Year 9.

The Licensee shall design and implement improvements to the public viewing window and counting room. The Licensee shall initiate design consultation with the Agencies during License Year 4, complete final designs by December 31 of License Year 4, initiate the improvements in License Year 5, and complete the improvements no later than April 1 of License Year 6.

The Licensee shall undertake a hydraulic study and engineering assessment of the existing Vernon fish ladder to inform potential modifications for improved effectiveness for American shad passage (this is the same hydraulic study discussed under section 3.4.2). The objectives of the hydraulic study are to determine the hydraulic conditions of the fish ladder and identify hydraulic related barriers to effective fish ladder passage. The engineering assessment will evaluate the condition of current as-built fish ladder components. The Licensee shall initiate consultation with the Agencies on design of the hydraulic study and scope of the engineering assessment no later than November 15 of License Year 2. The Licensee shall initiate the study no later than July 16 of License Year 3, and complete and report on the study no later than December 31 of License Year 4. The Licensee will use results of the study to develop design

modifications to improve shad passage through the Project. The Licensee shall initiate design consultation with the Agencies no later than January 1 of License Year 4 and complete final design plans (sufficient for construction bid purposes) no later than July 15 of License Year 5. The Licensee shall initiate approved shad ladder modifications by July 16 of License Year 5 and complete modifications no later than April 6 of License Year 6. Modifications shall be fully operational no later than April 7 of License Year 6.

The Licensee shall make any necessary repairs to the existing fish trap to achieve full functionality. Fish trap repairs shall be initiated in License Year 8 and completed no later than December 31 of License Year 9.

Specific passage and protection requirements and their associated implementation schedules and operational periods are provided in Table 3.4.3-2.

3.5 Fish Passage and Protection Measures at the Bellows Falls Project

The Licensee shall construct, operate, maintain, and evaluate the effectiveness of fish passage and protection facilities for Targeted Migrants at the Bellows Falls Project.

3.5.1 Downstream Passage and Protection

In License Years 3 and 4, the Licensee shall undertake a hydraulic study or a suitable alternative, designed to inform downstream passage/design options to achieve safe, timely, and effective passage for American eel. The Licensee shall initiate consultation with the Agencies on study design no later than January 1 of License Year 6, and complete and report on the study no later than December 31 of License Year 7. The Licensee will use results of the study to develop supplemental or additional operational and/or structural passage and protection measures at the dam and/or in the canal. The Licensee shall initiate design consultation with the Agencies no later than January 1 of License Year 8, and complete final design plans (sufficient for construction bid purposes) no later than December 31 of License Year 9. The Licensee shall initiate construction of approved eel passage and protection measures no later than July 16 of License Year 10 and complete construction by December 31 of License Year 11. Approved structural facilities and/or operational measures shall be fully operational no later than August 1 of License Year 12.

Specific passage and protection requirements and their associated implementation schedules and operational periods are provided in Table 3.5.1-1.

3.5.2 Upstream American Eel and Sea Lamprey Passage

3.5.2.1 Within Ladder Measures for Eel and Lamprey Passage for the period April 1 through July 15

The Licensee shall monitor eel and lamprey fish ladder use from April 1 through July 15 during License Years 2 and 3.

In License Year 4 the Licensee shall undertake a study using PIT technology to assess passage performance of American eel and sea lamprey within the Bellows Falls fish ladder. The Licensee shall initiate design consultation with the Agencies on the PIT study no later than September 1 of License Year 3. The Licensee shall initiate the field study no later than May 1 of License Year 4; and complete and report on the study no later than December 31 of License Year 4. Should the Agencies deem results of the monitoring or PIT-tag study insufficient to determine where passage impediments occur within the Bellows Falls ladder, the study design will be modified through consultation with the Agencies (e.g., additional PIT antennas deployed or moved to different locations) and an additional year of study will take place in License Year 5.

Should the Agencies determine that hydraulic-based impediments to passage exist within the fish ladder based on results from the PIT-tag study, the Licensee shall undertake a hydraulic study and engineering assessment of the existing Bellows Falls fish ladder to inform potential modifications for improved effectiveness for passage of American eel and/or sea lamprey. The objectives of the hydraulic study are to determine the hydraulic conditions of the fish ladder and identify hydraulic related barriers to effective eel and/or sea lamprey ladder passage. The engineering assessment will evaluate the condition of current as-built fish ladder components. The study and assessment shall be developed in consultation with the Agencies. The Licensee shall initiate consultation with the Agencies on the hydraulic study design and scope of engineering assessment no later than July 16 of License Year 5; and complete and report on the study no later than December 31 of License Year 6.

The Licensee will use results of these studies to develop design alternatives to improve eel and/or lamprey passage through the ladder for the period April 1 through July 15. The Licensee shall initiate design consultation with the Agencies no later than January 1 of License Year 7 and complete final design plans (sufficient for construction bid purposes) no later than July 15 of License Year 8. Approved eel/lamprey ladder modifications shall be completed by the Licensee no later than April 6 of License Year 9 and be fully operational no later than April 7 of License Year 9. These dates associated with initiating design consultation with the Agencies, finalizing design plans, final design approvals by the Agencies, and date of commencing operation shall be extended 1 year if an additional year of PIT tag study is performed.

3.5.2.2 Within Ladder Interim Measures for Eels for the period July 16 through November 15

The Licensee shall design, construct, operate, and maintain interim (possibly temporary) measures approved by the Agencies to pass American eels upstream for the period July 16

through November 15. The interim upstream eel passage facility shall consist of an eel ramp-trap, or similar design, as specified in USFWS Design Criteria (USFWS 2019). The eel ramp-trap will be located below the station, potentially within or near the entrance to the existing fish ladder at a location to be determined in consultation with the Agencies. The Licensee shall initiate design consultation for temporary upstream eel passage facilities with the Agencies no later than July 16 of License Year 2 and complete final design plans no later than December 31 of License Year 3. The Licensee shall complete construction no later than July 15 of License Year 4 and approved interim upstream eel passage facilities shall be fully operational no later than July 16 of License Year 4. Interim eel passage facilities shall be operated annually until dedicated upstream eel passage facilities are operational. The first two years of interim passage operation will include monitoring and reporting eel use and upstream passage. Based on the results of the monitoring, if the interim measure does not appear to pass eels in anticipated and consistent numbers, the Licensee will discuss next steps with the Agencies such as further monitoring and/or adjustment to the interim measure (e.g., location or design).

3.5.2.3 Permanent Upstream Eel Passage Measures for the period July 16 through November 15

Based on the PIT and hydraulic studies required pursuant to Section 3.5.2.1, ladder monitoring results, and upstream temporary eel passage data, the Licensee shall initiate consultation with the Agencies no later than July 1 in License Year 9 to determine whether existing information is sufficient to identify necessary locations for permanent upstream eel passage measures for the period July 16 through November 15 (i.e., via the temporary means, alternate permanent ramps or via the fish ladder), or if additional studies are needed.

Should the Agencies determine additional studies are not warranted, the Licensee shall select, subject to approval by the Agencies, the preferred method of upstream permanent passage no later than January 31 of License Year 10. The Licensee shall initiate design consultation for permanent upstream eel passage facilities with the Agencies no later than February 1 of License Year 10, and complete final design plans no later than December 31 of License Year 10. The Licensee shall complete construction of approved permanent upstream eel passage facilities such that they are fully operational no later than July 16 of License Year 11. Agencies acknowledge the 6.5 month window to construct may be negatively impacted by weather and river conditions or ability to procure materials.

Should the Agencies determine additional studies are warranted, the Licensee shall undertake them in License Year 10. The Licensee shall initiate consultation with the Agencies on the design of additional studies no later than February 15 of License Year 10. Results shall be provided to the Agencies by December 31 of License Year 10. Based on study results, the Licensee shall decide on an Agency-approved preferred method of permanent upstream passage

no later than January 31 of License Year 11. The Licensee shall initiate design consultation for permanent upstream eel passage facilities no later than February 1 of License Year 11, and complete final design plans no later than December 31 of License Year 11. The Licensee shall complete construction of approved permanent upstream eel passage facilities such that they are fully operational no later than July 16 of License Year 12. Agencies acknowledge the 6.5 month window to construct may be negatively impacted by weather and river conditions or ability to procure materials.

3.5.2.4 Permanent Upstream Eel Passage Measures in the Bellows Falls Bypass Reach

The Licensee shall initiate consultation with the Agencies on an eel survey study plan no later than July 1 of the year the Salmon Dam is removed or License Year 6, whichever is later. The first passage season after removal of the Salmon Dam or License Year 7, whichever is later, the Licensee shall undertake the upstream eel survey between May and October to determine where juvenile eels congregate (e.g., near the fish ladder, in the tailrace, near the spillway, etc.). The Licensee will report the results and consult with the Agencies upon completion of the study and prior to initiating designs for a permanent upstream eel passage design. Should study results indicate an area of eel concentration in the vicinity of the spillway, the Licensee shall install a single upstream eel passage facility within the bypass reach.

Design of a permanent upstream eel passage facility in the bypass reach, if determined necessary by the Agencies, shall occur in consultation with, and require approval by the Agencies. The Licensee shall initiate design consultation no later than January 1 and complete final design plans no later than December 31 of the year following the results of the upstream eel survey or License Year 8, whichever is later. The Licensee shall complete construction of an approved bypass reach upstream eel passage facility no later than July 31 of the second year following completion of the upstream eel survey or License Year 9, whichever is later. Agencies acknowledge the 7 month window to construct may be negatively impacted by weather and river (spill conditions in the bypass) conditions or ability to procure materials. If the Licensee successfully completes construction by July 31 of the second year following the results of the upstream eel survey or License Year 9, whichever is later, it will immediately begin operating the permanent bypass eel passage on August 1 of that same year. Otherwise, the Licensee will operate the permanent bypass eel passage no later than May 1 of the following year (i.e., the third year following the results of the upstream eel survey or License Year 10).

Specific passage and protection requirements and their associated implementation schedules and operational periods are provided in Table 3.5.2-1.

3.6 Fish Passage and Protection Measures at the Wilder Project

The Licensee shall construct, operate, maintain, and evaluate the effectiveness of fish passage and protection facilities for American eel and sea lamprey at the Wilder Project.

3.6.1 Downstream Passage and Protection

The Licensee shall undertake a hydraulic study or a suitable alternative, designed to inform downstream passage/design options to achieve safe, timely, and effective passage for American eel. The Licensee shall initiate consultation with the Agencies on study design no later than January 1 of License Year 10 and undertake, complete and report on the study no later than December 31 of License Year 11. The Licensee will use results of the study to develop alternatives to provide safe, timely, and effective passage for American eels. The Licensee shall initiate design consultation of the passage and protection system(s) with the Agencies, no later than January 1 in License Year 12 and complete final design plans (sufficient for construction bid purposes) no later than December 31 of License Year 13. The Licensee shall initiate construction of approved eel passage and protection measures no later than July 16 of License Year 14 and complete construction by December 31 of License Year 15. Approved structural facilities and/or operational measures shall be fully operational no later than August 1 of License Year 16.

Specific passage and protection requirements and their associated implementation schedules and operational periods are provided in Table 3.6.1-1.

3.6.2 Upstream American Eel and Sea Lamprey Passage

3.6.2.1 Within Ladder Measures for Eel and Lamprey Passage for the period April 7 through July 15

The Licensee shall monitor 2 years of eel and lamprey fish ladder use (number, timing and size estimation) from April 7 through July 15 during License Years 1 and 3. Monitoring data will be used by the Agencies to determine if fish ladder operational dates need to be adjusted to protect downstream migrants (i.e., manage the number of eels passing upstream until downstream measures in place).

During License Year 8, the Licensee shall undertake a study using PIT technology to assess passage performance of American eel and sea lamprey within the Wilder fish ladder. The Licensee shall initiate consultation with the Agencies on the PIT study design no later than September 1 of License Year 7. The Licensee shall initiate the study no later than May 1 and complete and report on the study no later than December 31 of License Year 8. Should the Agencies deem results of this study insufficient to determine where passage impediments occur within the Wilder ladder, the study design will be modified through consultation with the

Agencies (e.g., additional PIT antennas deployed or moved to different locations) and an additional year of study will take place in License Year 9.

Should the Agencies determine that hydraulic-based impediments to passage exist based on PIT study results, the Licensee shall undertake a hydraulic study and an engineering assessment of the existing Wilder fish ladder to inform potential modifications for improved effectiveness for passage of American eel and/or sea lamprey. The objectives of the hydraulic study are to determine the hydraulic conditions of the fish ladder and identify hydraulic related barriers to effective eel and/or sea lamprey ladder passage. The engineering assessment will evaluate the condition of current as-built fish ladder components. The Licensee shall initiate consultation with the Agencies on the hydraulic study design and scope of engineering assessment no later than July 16 of License Year 9 and complete and report on the study and assessment no later than December 31 of License Year 10.

The Licensee will use results of the PIT study, hydraulic study, engineering assessment, and monitoring study to develop design alternatives to improve eel and/or lamprey passage through the ladder during the upstream anadromous fish passage season. Design of ladder modification(s) shall occur in consultation with, and require approval by, the Agencies. The Licensee shall initiate design consultation no later than January 1 of License Year 11 and complete final design plans (sufficient for construction bid purposes) no later than July 15 of License Year 12. Approved eel/lamprey ladder modifications shall be completed no later than December 31 of License Year 13 and be fully operational no later than April 7 of License Year 14.

3.6.2.3 Permanent Upstream Eel Passage Measures

The Licensee shall undertake an upstream eel survey in the vicinity of the powerhouse and spillway to determine areas of eel concentration at the Project. The Licensee shall initiate study design consultation for the upstream eel survey with the Agencies no later than July 1 of License Year 7. The Licensee shall conduct the study from May through October and provide survey results to the Agencies no later than December 31 in License Year 8.

Based on the PIT and hydraulic studies required pursuant to Section 3.6.2.1, ladder monitoring results, upstream temporary eel passage data, and the upstream eel survey, the Licensee shall consult with the Agencies in License Year 11 to determine whether existing information is sufficient to identify the location for permanent upstream eel passage measures, or if additional studies are needed.

Should the Agencies determine additional studies are not warranted, the Licensee shall decide on an Agency-approved preferred method of upstream permanent passage no later than December 31 of License Year 11. The Licensee shall initiate design consultation for permanent upstream eel passage facilities with the Agencies no later than February 1 of License Year 12, and complete final design plans no later than December 31 of License Year 12. The Licensee shall complete construction of approved permanent upstream eel passage facilities (potentially consistent with eel/lamprey ladder modifications) such that they are fully operational no later than July 16 of License Year 13.

Should the Agencies determine additional studies are warranted, the Licensee shall initiate study design consultation with the Agencies no later than January 1 in License Year 12. Results shall be provided to the Agencies by December 31 of License Year 12. Based on study results, the Agencies shall decide the preferred method of permanent upstream passage no later than January 31 of License Year 13. The Licensee shall initiate design consultation for permanent upstream eel passage facilities with the Agencies no later than February 1 of License Year 13, and complete final design plans no later than December 31 of License Year 13. The Licensee shall complete construction of approved permanent upstream eel passage facilities such that they are fully operational no later than July 16 of License Year 14. Agencies acknowledge the 6.5 month window to construct may be negatively impacted by weather and river conditions or ability to procure materials.

Specific passage and protection requirements and their associated implementation schedules and operational periods are provided in Table 3.6.2-1.

3.7. Fish Passage Facilities Operations and Maintenance Plan

The Licensee shall develop and implement a Fish Passage Facilities Operations and Maintenance Plan (FOMP). The FOMP shall detail how and when the fishways will be operated and describe routine maintenance activities that will occur both during and outside of the fish passage seasons. The FOMP will include a provision to provide annual fishway Operation and Maintenance (O&M) reports that summarize the status of the fish passage facilities, identify needed repairs or equipment replacement, etc. The O&M report shall be submitted to the Agencies by January 31 annually. The FOMP shall be developed in consultation with and require approval by the Agencies prior to submitting the final FOMP to the FERC for approval. The FOMP shall be in place no later than six (6) months from the first fish passage facilities (or passage facility improvements) coming on-line, and shall be updated as needed as new passage facilities, or modifications to existing facilities, are placed into service; and based on information obtained from operation of the facilities pursuant to the annual O&M reports.

3.8 Fish Passage Facilities Effectiveness Testing

The Licensee shall conduct a shakedown assessment for each fish passage facility during the first year of operation followed by two years of representative, quantitative effectiveness studies (except as provided in Section 3.1). No later than six (6) months prior to each identified fish passage facility becoming operational, the Licensee shall file a facility-specific Passage Effectiveness Studies Plan (PESP) for Commission approval. The PESP shall be developed in consultation with and require approval by the Agencies, prior to submitting PESPs to the FERC for approval. The PESP shall detail how the constructed and operational passage facilities will be evaluated for their effectiveness at passing Targeted Migrants. Study results will be used to inform potential remedial measures to improve passage efficiency of the measures designed and constructed under this Agreement. Each PESP may be supplemented based on information obtained from operation of the facilities pursuant to the annual O&M reports and/or previous study results.

American shad performance standards upon which the results of any required effectiveness studies shall be reviewed and compared are summarized in Table 3.8-1.

Table 3.8-1. Summary of upstream and downstream performance standards for American shad passage facilities at the Vernon Project.

Facility	Efficiency	Delay
Downstream Passage and Protection	95% through-Project survival based on the number of test fish that approach within 1 km of a project area [(# passed alive/# arrive)*100].	Test fish that pass the project do so within 24 hours of arriving within 1 km of the project area.
Upstream Anadromous Passage	75% upstream efficiency based on the number of test fish that approach within 1 km of the project area [(# passed/# arrive)*100].	Test fish that pass the project do so within 48 hours of arriving within 1 km of the project area.

In addition, given regional management objectives and cumulative effects of downstream passage through multiple hydropower projects, the Agencies have a goal of 95% through-project survival for American eels.

REFERENCES

USFWS (U.S. Fish and Wildlife Service). 2019. Fish Passage Engineering Design Criteria. USFWS, Northeast Region R5, Hadley, Massachusetts.

IN WITNESS WHEREOF, the Parties have caused this Agreement to be executed by their duly authorized representatives as of the date first above written.

Great River Hydro, LLC

By: _____

Name: Scott D. Hall

Title: President & CEO

United States Fish and Wildlife Service

By: _____

Name: _____

Title: _____

New Hampshire Fish and Game Department

By: _____

Name: Scott R. Mason

Title: Director, New Hampshire Fish and Game

Vermont Department of Fish and Wildlife

By: _____

Name: Christopher A. Herrick

Title: Commissioner, Vermont Fish & Wildlife

IN WITNESS WHEREOF, the Parties have caused this Agreement to be executed by their duly authorized representatives as of the date first above written.

Great River Hydro, LLC

By: _____

Name: _____

Title: _____

United States Fish and Wildlife Service

By: DAVID SIMMONS Digitally signed by DAVID SIMMONS Date: 2022.07.15 14:03:45 -04'00'

Name: David Simmons

Title: Acting Supervisor, New England Field Office

New Hampshire Fish and Game Department

By: Scott R. Mason

Name: Scott R. Mason

Title: Director, New Hampshire Fish and Game

Vermont Department of Fish and Wildlife

By: Christopher A. Herrick

Name: Christopher A. Herrick

Title: Commissioner, Vermont Fish & Wildlife

APPENDIX A

FISH PASSAGE IMPLEMENTATION TABLES

Table 3.4.1-1. VERNON DOWNSTREAM PASSAGE & PROTECTION				
Item	**Measure**	**Implementation Schedule**	**Operation Period**	**Effectiveness Studies**
1	Hydraulic study above the dam to inform downstream passage design/options.	• Initiate Study Design Consultation NLT 1/1 of License Year 2. • Initiate and Complete Study NLT 12/31 in License Year 3.		
2	Design, construct, operate, maintain, and study effectiveness of measures to pass eels and alosines downstream.	• Design consultation initiated by 7/1 of License Year 3; design completed NLT 12/31 License Year 4. • Initiate construction/modifications (mods) in License Year 5 and complete no later than Dec. 31 of License Year 6. • Operate no later than April 7 of License Year 7.	April 7 to December 1[A]	Yr 1: shakedown[B]; Yr 2: quantitative effectiveness study[C]; Yr 3: additional study year, if needed (i.e., Yr 2 anomalous[D], incomplete, etc. or issues found/mods made); Yr 4: additional study year, if needed (Yr 3 anomalous, incomplete, etc. or issues found/mods made).

A. Downstream passage initiated concurrent with upstream passage for shad. Future refinement of the timing may be made by the Agencies as information on the behavior of migrants at the Project is documented.

B. Shakedown refers to assessing whether all components of the upstream fish passage facility are operating as designed.

C. Quantitative effectiveness studies are based on a study design that allows for numeric, objective assessments of data collected.

D. Anomalous conditions are those outside the bounds of 25th to 75th percentile conditions for a given parameter (e.g., flow, temperature, etc.).

Table 3.4.2-1. VERNON UPSTREAM AMERICAN EEL & SEA LAMPREY PASSAGE				
Item	**Measure**	**Implementation Schedule**	**Operation Period[A]**	**Effectiveness Studies**
3a	Undertake fish ladder hydraulic study.	• Initiate Study Design Consultation NLT 11/15 in License Year 2. • Initiate Study NLT 7/16 in License Year 3. • Complete Study NLT 12/31 in License Year 4.		
3b	Conduct upstream Eel/Lamprey passage study using Passive Integrated Transponder technology.	• Initiate Study Design Consultation NLT 7/1 in License Year 3. • Conduct PIT study from May through July 15 in License Year 4 (during License Year 5, if needed).	May 1 to July 15	
3c	Design, construct, operate, maintain, and study effectiveness of permanent upstream ladder improvement measures to pass eels and lamprey upstream.	• Initiate design consultation in License Year 4 and complete design consultation NLT 7/15 in License Year 5. • Initiate construction of permanent upstream ladder improvement measures NLT 7/16 in License Year 5 and complete improvement measures NLT 4/6 in License Year 6. • Operate permanent upstream ladder improvement measures NLT 4/7 in License Year 6. • All deadlines stated above extended 1 year if additional study under 3b required in License Year 6.	May 1 to July 15	Yr 1: shakedown[B]; Yr 2: quantitative effectiveness study[C]; Yr 3: additional study year, if needed (i.e., Yr 2 anomalous[D], incomplete, etc. or issues found/mods made); Yr 4: additional study year, if needed (Yr 3 anomalous, incomplete, etc. or issues found/mods made).
4a	Design, construct, operate, maintain, and monitor interim, possibly temporary, measures to pass eels upstream after the anadromous passage season.	• Initiate design consultation in License Year 2. • Complete construction of interim eel passage measures NLT 7/15 in License Year 3. • Operate interim eel passage measures NLT 7/16 in License Year 3.	July 16 to November 15	Yr 1: shakedown.[B]

Table 3.4.2-1. VERNON UPSTREAM AMERICAN EEL & SEA LAMPREY PASSAGE				
Item	**Measure**	**Implementation Schedule**	**Operation Period[A]**	**Effectiveness Studies**
4b	Permanent upstream eel passage outside of anadromous passage season.	• Consultation and determination on need for additional studies regarding permanent eel passage measures initiated NLT 7/1 in License Year 9 and completed NLT 1/31 in License Year 10. • If no additional studies required: ○ Design Consultation initiated 2/1 of License Year 10 and Completed by 12/31 in License Year 10. ○ Complete construction NLT 7/15 in License Year 11. ○ Operate measure NLT 7/16 in License Year 11. • If additional studies are required: ○ Study design consultation initiated NLT 2/15 in License Year 10 and completed NLT 1/1 in License Year 11. ○ Initiate design consultation in February of License Year 11 and complete design consultation by 12/31 in License Year 11. ○ Complete construction of permanent upstream eel passage measures NLT 7/15 in License Year 12. ○ Operate permanent eel passage measure NLT 7/16 in License Year 12.	July 16 – November 15	

A. Future refinement of the timing may be made by the Agencies as information on the behavior of migrants at the Project is documented.
B. Shakedown refers to assessing whether all components of the upstream fish passage facility are operating correctly.
C. Quantitative effectiveness studies are based on a study design that allows for numeric, objective assessments of data collected.
D. Anomalous conditions are those outside the bounds of 25th to 75th percentile conditions for a given parameter (e.g., flow, temperature, etc.).

Table 3.4.3-2. VERNON UPSTREAM ANADROMOUS				
Item	**Measure**	**Implementation Schedule**	**Operation Period[A]**	**Effectiveness Studies**
5a	Evaluate whether fish are trapped behind collection gallery below powerhouse.	Complete by 7/16 in License Year 7.		
5b	Design and implement solution if fish are trapped behind collection gallery.	Construct or implement mitigation solutions NLT 12/31 in License Year 8 in order to have no issues during the fish passage season starting 4/7 in License Year 9.	April 7 to July 15	
6	Design and implement improvements to counting window and room.	• Design Consultation initiated in License Year 4 and completed by 12/31 in License Year 4. • Initiate construction of improvements during License Year 5 and complete NLT 4/1 in License Year 6. • All improvements in place to operate and function NLT 4/7 in License Year 6.		
7a	Undertake fish ladder hydraulic study and engineering assessment.	• Initiate Study Design Consultation NLT 11/15 in License Year 2. • Initiate study and assessment NLT 7/16 in License Year 3. • Complete Study NLT 12/31 in License Year 4.		
7b	Additional fish ladder modifications (mods): consult/design, install, operate, maintain, and study effectiveness of mods.	• Initiate design consultation in License Year 4 and complete design consultation NLT 7/15 in License Year 5. • Construct additional ladder modifications NLT 7/16 in License Year 5 and complete NLT 4/6 in License Year 6. • Operate additional ladder modifications NLT 4/7 in License Year 6.	April 7 to July 15	Yr 1: shakedown[B]; Yr 2: quantitative effectiveness study[C]; Yr 3: additional study year, if needed (i.e., Yr 2 anomalous[D], incomplete, etc. or issues found/mods made); Yr 4: additional study year, if needed (Yr 3 anomalous, incomplete, etc. or issues found/mods made).
7c	Fish trap repair.	Initiate overhaul of Vernon Fish ladder trapping facility in License Year 8 and complete overhaul NLT 12/31 in License Year 9.		

A. Actual dates of operation are based on passage of fish at the previous downstream fishway. Vernon ladder shall be operational within three days of the Turners Falls fishways being opened.
B. Shakedown refers to assessing whether all components of the upstream fish passage facility are operating correctly.
C. Quantitative effectiveness studies are based on a study design that allows for numeric, objective assessments of data collected.
D. Anomalous conditions are those outside the bounds of 25th to 75th percentile conditions for a given parameter (e.g., flow, temperature, etc.).

Table 3.5.1-1. BELLOWS FALLS DOWNSTREAM PASSAGE & PROTECTION				
Item	**Measure**	**Implementation Schedule**	**Operation Period[A]**	**Effectiveness Studies**
8a	Hydraulic study above the dam to inform downstream passage design/options.	• Initiate Study Design Consultation NLT 1/1 of License Year 6. • Initiate and Complete Study NLT 12/31 of License Year 7.		
8b	Design, construct, operate, maintain, and study effectiveness of measures to pass eels downstream.	• Design consultation initiated NLT 1/ 1 of License Year 8; design completed NLT 7/15 of License Year 10. • Initiate construction/modifications (mods) NLT 7/16 in License Year 10 and complete no later than 12/31 of License Year 11. • Operate no later than 4/7 of License Year 12.	August 1 to December 1	Yr 1: shakedown[B]; Yr 2: quantitative effectiveness study[C]; Yr 3: additional study year, if needed (i.e., Yr 2 anomalous[D], incomplete, etc. or issues found/modifications made); Yr 4: additional study year, if needed (Yr 3 anomalous, incomplete, etc. or issues found/modifications made).

A. Future refinement of the timing may be made by the Agencies as information on the behavior of migrants at the Project is documented.
B. Shakedown refers to assessing whether all components of the upstream fish passage facility are operating correctly.
C. Quantitative effectiveness studies are based on a study design that allows for numeric, objective assessments of data collected.
D. Anomalous conditions are those outside the bounds of 25th to 75th percentile conditions for a given parameter (e.g., flow, temperature, etc.).

Table 3.5.2-1. BELLOWS FALLS UPSTREAM AMERICAN EEL & SEA LAMPREY PASSAGE				
Item	**Measure**	**Implementation Schedule**	**Operation Period[A]**	**Effectiveness Studies**
9a	Monitor fish ladder use by American eel (eel) and Sea Lamprey (lamprey).	Monitor during License Years 2 and 3.	May 1 – July 15	
9b	Upstream eel/lamprey passage studies (PIT tag study of ladder).	• Initiate Study Design Consultation NLT 9/1 in License Year 3. • Conduct PIT study from May through July 15 in License Year 4 (during License Year 5, if needed).	May 1 to July 15	
9c	Undertake fish ladder hydraulic study and engineering assessment, if necessary.	• Initiate Study Design Consultation NLT 7/16 in License Year 5. • Conduct study and assessment NLT 12/31 in License Year 6.		
9d	Consultation, design, and construction of upstream fish ladder modifications for eel and lamprey during the anadromous fish passage season.	• Initiate design consultation in License Year 7 and complete design consultation NLT 7/15 in License Year 8. • Construct permanent upstream ladder improvement measures NLT 7/16 in License Year 8 and complete NLT 4/6 in License Year 9. • Operate permanent upstream ladder improvement measures NLT 4/7 in License Year 9. • All deadlines stated above extended 1 year if additional study under 9b required in License Year 5.	May 1 to July 15	Yr 1: shakedown[B]; Yr 2: quantitative effectiveness study[C]; Yr 3: additional study year, if needed (i.e., Yr 2 anomalous[D], incomplete, etc. or issues found/mods made); Yr 4: additional study year, if needed (Yr 3 anomalous, incomplete, etc. or issues found/mods made).
10a	Design, construct, operate, maintain, and monitor interim, possibly temporary, measures to pass eels upstream after the anadromous passage season (excluding the bypass reach).	• Initiate design consultation NLT 7/16 in License Year 2 and complete design consultation NLT 12/31 in License Year 3. • Complete construction of interim eel passage measures NLT 7/15 in License Year 4. • Operate interim eel passage measures NLT 7/16 in License Year 3.	July 16 to November 15 (until permanent measures become operational)	

Table 3.5.2-1. BELLOWS FALLS UPSTREAM AMERICAN EEL & SEA LAMPREY PASSAGE				
Item	**Measure**	**Implementation Schedule**	**Operation Period[A]**	**Effectiveness Studies**
10b	Permanent upstream eel passage outside of anadromous passage season (excluding the bypass reach).	• Consultation and determination on need for additional studies regarding permanent eel passage measures initiated NLT 7/1 in License Year 9 and completed NLT 1/31 in License Year 10; • If no additional studies required: o Design consultation initiated 2/1 of License Year 10 and completed by 12/31 in License Year 10 o Complete construction NLT 7/15 in License Year 11 o Operate measure NLT 7/16 in License Year 11 • If additional studies are required: o Study design consultation initiated NLT 2/15 in License Year 10 and completed NLT 1/1 in License Year 11 o Initiate design consultation in February of License Year 11 and complete design consultation by 12/31 in License Year 11 o Complete construction of permanent upstream eel passage measures NLT 7/15 in License Year 12 o Operate permanent eel passage measure NLT 7/16 in License Year 12	July 16 to November 15	
10c	Undertake upstream eel survey in bypass reach.	• Study design consultation initiated NLT 7/1 in License Year 6 or year fish barrier dam is removed, whichever is later. • Conduct eel survey study from May through October in License Year 7 or in first year following barrier dam removal, whichever is later.	May 1 to November 15	

A. Future refinement of the timing may be made by the Agencies as information on the behavior of migrants at the Project is documented.
B. Shakedown refers to assessing whether all components of the upstream fish passage facility are operating correctly.
C. Quantitative effectiveness studies are based on a study design that allows for numeric, objective assessments of data collected.
D. Anomalous conditions are those outside the bounds of 25th to 75th percentile conditions for a given parameter (e.g., flow, temperature, etc.).

Table 3.5.2-1. BELLOWS FALLS UPSTREAM AMERICAN EEL & SEA LAMPREY PASSAGE (cont'd)				
Item	**Measure**	**Implementation Schedule**	**Operation Period[A]**	**Effectiveness Studies**
10d	Consultation, design, and construction of additional upstream eel passage facilities in bypass reach.	• Initiate design consultation in February of License Year 8 and complete design consultation by 12/31 in License Year 8 or the year following the completion of the eel survey study, whichever is later. • Complete construction of permanent upstream eel passage measure in bypass NLT 7/31 in License Year 9 or in the second year following the completion of the eel survey study, whichever is later. • If the Licensee successfully completes construction by 7/31 of the second year following the results of the upstream eel survey or License Year 9, whichever is later, it will immediately begin operating the permanent bypass eel passage on August 1 of that same year. Otherwise, the Licensee will operate the permanent bypass eel passage NLT 5/1 of the following year.	May 1 to November 15	Yr 1: shakedown[B]; Yr 2: quantitative effectiveness study[C]; Yr 3: additional study year, if needed (i.e., Yr 2 anomalous[D], incomplete, etc. or issues found/mods made); Yr 4: additional study year, if needed (Yr 3 anomalous, incomplete, etc. or issues found/mods made).

A. Future refinement of the timing may be made by the Agencies as information on the behavior of migrants at the Project is documented.
B. Shakedown refers to assessing whether all components of the upstream fish passage facility are operating correctly.
C. Quantitative effectiveness studies are based on a study design that allows for numeric, objective assessments of data collected.
D. Anomalous conditions are those outside the bounds of 25th to 75th percentile conditions for a given parameter (e.g., flow, temperature, etc.).

Table 3.6.1-1. WILDER DOWNSTREAM PASSAGE & PROTECTION				
Item	**Measure**	**Implementation Schedule**	**Operation Period[A]**	**Effectiveness Studies**
11a	Hydraulic study above the dam to inform downstream passage design/options	• Initiate study design consultation NLT 1/1 of License Year 10. • Initiate and complete study NLT 12/31 of License Year 11.		
11b	Design, construct, operate, maintain, and study effectiveness of measures to pass eels downstream.	• Design consultation initiated NLT 1/1 of License Year 12; design completed NLT 12/31 of License Year 13. • Initiate construction/modifications (mods) NLT 7/16 in License Year 14 and complete NLT 12/31 of License Year 15. • Operate NLT 8/1 of License Year 16.	August 1 to December 1	Yr 1: shakedown[B]; Yr 2: quantitative effectiveness study[C]; Yr 3: additional study year, if needed (i.e., Yr 2 anomalous[D], incomplete, etc. or issues found/mods made); Yr 4: additional study year, if needed (Yr 3 anomalous, incomplete, etc. or issues found/mods made).

A. Future refinement of the timing may be made by the Agencies as information on the behavior of migrants at the Project is documented.
B. Shakedown refers to assessing whether all components of the upstream fish passage facility are operating correctly.
C. Quantitative effectiveness studies are based on a study design that allows for numeric, objective assessments of data collected.
D. Anomalous conditions are those outside the bounds of 25th to 75th percentile conditions for a given parameter (e.g., flow, temperature, etc.).

Table 3.6.2-1. WILDER UPSTREAM AMERICAN EEL & SEA LAMPREY PASSAGE				
Item	**Measure**	**Implementation Schedule**	**Operation Period[A]**	**Effectiveness Studies**
12a	Monitor fish ladder use by American eel (eel) and Sea Lamprey (lamprey).	Monitor during License Years 1 and 3.	April 7 to July 15	
12b	Upstream eel/lamprey passage studies (PIT tag study of ladder).	• Initiate study design consultation NLT 9/1 in License Year 7. • Conduct PIT study from May through July 15 in License Year 8 (during License Year 9, if needed).	April 7 to July 15	
12c	Undertake fish ladder hydraulic study and engineering assessment, if necessary.	• Initiate study design consultation NLT 7/16 in License Year 9. • Conduct study and assessment NLT 12/31 in License Year 10.		
12d	Consultation, design, and construction of upstream fish ladder modifications for eel and lamprey during the anadromous fish passage season.	• Initiate design consultation in License Year 11 and complete design consultation NLT 7/15 in License Year 12. • Construct permanent upstream ladder improvement measures NLT 7/16 in License Year 12 and complete NLT 12/31 in License Year 13. • Operate permanent upstream ladder improvement measures NLT 4/7 in License Year 14. • All deadlines stated above extended 1 year if additional study under 12b required in License Year 9.	May 1 to July 15	Yr 1: shakedown[B]; Yr 2: quantitative effectiveness study[C]; Yr 3: additional study year, if needed (i.e., Yr 2 anomalous[D], incomplete, etc. or issues found/mods made); Yr 4: additional study year, if needed (Yr 3 anomalous, incomplete, etc. or issues found/mods made).

A. Future refinement of the timing may be made by the Agencies as information on the behavior of migrants at the Project is documented.
B. Shakedown refers to assessing whether all components of the upstream fish passage facility are operating correctly.
C. Quantitative effectiveness studies are based on a study design that allows for numeric, objective assessments of data collected.
D. Anomalous conditions are those outside the bounds of 25th to 75th percentile conditions for a given parameter (e.g., flow, temperature, etc.).

Table 3.6.2-1. WILDER UPSTREAM AMERICAN EEL & SEA LAMPREY PASSAGE (cont'd)				
Item	**Measure**	**Implementation Schedule**	**Operation Period[A]**	**Effectiveness Studies**
13a	Undertake upstream eel survey in the vicinity of the powerhouse and along the spillway.	• Eel survey study design consultation initiated NLT 7/1 in License Year 7. • Conduct eel survey study from May through October in License Year 8.	May 1 to November 15	
13b	Consultation, design, and construction of dedicated upstream eel passage facilities.	• Consultation and determination on need for additional studies regarding dedicated eel passage measures initiated NLT 7/1 in License Year 11 and completed NLT 12/31 in License Year 11. • If no additional studies required: ○ Design consultation initiated 2/1 of License Year 12 and completed by 12/31 in License Year 12. ○ Complete construction NLT 7/15 in License Year 13. ○ Operate measures NLT 7/16 in License Year 13. • If additional studies are required: ○ Initiate study design consultation NLT 1/1 in License Year 12 and complete study NLT 12/31 in License Year 12. ○ Initiate design consultation in February of License Year 13 and complete design consultation by 12/31 in License Year 13. ○ Complete construction of permanent upstream eel passage measures NLT 7/15 in License Year 14. ○ Operate permanent eel passage measures NLT 7/16 in License Year 14.	May 1 to November 15	Yr 1: shakedown[B]; Yr 2: quantitative effectiveness study[C]; Yr 3: additional study year, if needed (i.e., Yr 2 anomalous[D], incomplete, etc. or issues found/mods made); Yr 4: additional study year, if needed (Yr 3 anomalous, incomplete, etc. or issues found/mods made).

A. Future refinement of the timing may be made by the Agencies as information on the behavior of migrants at the Project is documented.
B. Shakedown refers to assessing whether all components of the upstream fish passage facility are operating correctly.
C. Quantitative effectiveness studies are based on a study design that allows for numeric, objective assessments of data collected.
D. Anomalous conditions are those outside the bounds of 25th to 75th percentile conditions for a given parameter (e.g., flow, temperature, etc.).

APPENDIX B

PROJECT SPECIFIC FISH PASSAGE IMPLEMENTATION CHART

Appendix B - Project Specific Fish Passage Implementation Chart

Project and Fish Passage Mitigation Measure	License Issue Year 0	LICENSE YEAR (Year Following License Issuance or Year 0)							
		1	2	3	4	5	6	7	8
VERNON	MONITOR	STUDY	DESIGN	CONSTRUCT	OPERATE				
3.4.2.1 Design and Complete Vernon Ladder Hydraulic Study for eels/lamprey (NLT): design, perform, report			Initiate study design NLT 11/15 Y2	Initiate study NLT 7/16 Y3	complete NLT 12/21 Y6				
3.4.3 Hydraulic and Engineering Assessment of Ladder - shad passage same as 3.2.2.1									
3.4.2.1 Complete Vernon Ladder PIT Study for eels/lamprey: design, perform, and report				Initiate study design NLT 7/1 Y3	complete NLT 12/21 Y6*				
3.4.2.1 Design Consultation and Final Design on Upstream ladder passage measures					Initiate Y6	Complete NLT 7/15 Y5			
3.4.3.1 Design Consultation and Final Design - shad related ladder passage measures					Initiate 1/1 Y6	Complete NLT 7/15 Y5			
3.4.2.1. Construction of Permanent Upstream Eel/Sea Lamprey Ladder improvements						Initiate NLT 7/16 Y5	Complete NLT 6/6 Y6		
3.4.2.1 OPERATE PERMANENT UPSTREAM EEL/SEA LAMPREY LADDER IMPROVEMENTS							NLT 4/7 Y6		
3.4.3 Construction of Permanent Upstream Ladder shad related measures						Initiate NLT 7/16 Y5	Complete NLT 6/6 Y6		
3.4.3.1 OPERATE PERMANENT UPSTREAM SHAD LADDER IMPROVEMENTS							NLT 4/7 Y6		
3.4.2.2 Design Consultation and Final Design for Interim In-ladder eel passage (7/16-11/15)			Initiate NLT 1/1 complete NLT 12/21 Y2						
3.4.2.2 Construction of Interim In-ladder eel passage (7/16-11/15)				complete NLT 7/15 Y3					
3.4.2.2 OPERATE INTERIM UPSTREAM EEL/SEA LAMPREY LADDER IMPROVEMENTS				NLT 7/16 Y3					
3.4.2.3 Study info determination for permanent eel passage measures (7/16-11/15)									
3.4.2.3 IF NO FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)									
3.4.2.3 IF NO FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)									
3.4.2.3 IF NO FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE 7/16-11/15									
3.4.2.3 IF FURTHER STUDY: Design, Perform and Report additional study									
3.4.2.3 IF FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)									
3.4.2.3 IF FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)									
3.4.2.3 IF FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)									
3.4.1 Hydraulic Study or Alternative above dam for downstream passage: design, perform, report			Initiate study design NLT 1/1 Y2	complete & report on study NLT 12/21 Y3					
3.4.1 Design Consultation and Final Design on Downstream passage measures				Initiate NLT 7/1 Y3	complete NLT 12/21 Y6				
3.4.1. Construction of Shad/Eel Downstream measures						Initiate Y5	complete NLT 12/21 Y6		
3.4.1 OPERATE PERMANENT DOWNSTREAM SHAD/EEL MEASURES								NLT 4/7 Y7	
3.4.3 Complete overhaul and repairs to existing fish trap									Initiate Y8
3.4.3 Evaluate, determine and report if fish are trapped behind collection gallery								Complete NLT 7/16 Yr 7	
3.2.3 IF TRAPPED: Implement Prevention Solution									complete NLT 12/21 Y8
3.4.3 Design improvements to public viewing and counting windows					complete NLT 12/21 Y6				
3.4.3 Make and complete improvements to public viewing and counting windows						Initiate Y5	complete NLT 4/1 Y6		
3.4.3 Complete improvements to public viewing and counting windows							NLT 4/7 Y6		
BELLOWS FALLS	MONITOR	STUDY	DESIGN	CONSTRUCT	OPERATE				
3.5.2.1 Monitor eel and lamprey fish ladder use			4/1 - 7/15 Y2	4/1 - 7/15 Y3					
3.5.2.1 Complete Bellows Falls Ladder PIT Study for eels/lamprey: design, perform, report				Initiate study design NLT 9/1 Y3	complete NLT 12/21 Y6*				
3.5.2.1 Design and Complete Ladder Hydraulic Study for eels/lamprey if needed						Initiate NLT 7/16 Y5	complete NLT 12/21 Y6		
3.5.2.1 Design Consultation and Final Design on Upstream ladder passage measures								Initiate NLT 1/1 Y7	complete NLT 7/15 Y 8
3.5.2.1. Construction of Permanent Upstream Eel/Sea Lamprey Ladder improvements									Initiate NLT 7/16 Y8
3.5.2.1 OPERATE PERMANENT UPSTREAM EEL/SEA LAMPREY LADDER IMPROVEMENTS									
3.5.2.2 Design Consultation and Final Design for Interim In-ladder eel passage (7/16-11/15)			Initiate NLT 7/16 Y2	complete NLT 12/21 Y3					
3.5.2.2 Construction of Interim In-ladder eel passage (7/16-11/15)					complete NLT 7/15 Y 4				
3.5.2.2 OPERATE INTERIM IN-LADDER EEL PASSAGE (7/16-11/15)					NLT 7/16 Y4				
MONITOR INTERIM IN-LADDER EEL PASSAGE (7/16-11/15)					7/16-11/15	7/16-11/15			
3.5.2.4 Survey Bypass Reach for where juvenile eels congregate 1 Yr after barrier dam is out: design, perform, report							Initiate Survey design NLT 7/1 Y6	Initiate study May - Oct Y7 Earliest	
3.5.2.4 Consultation and Finalize Design for permanent bypass reach eel passage facility									Initiate NLT 1/1 complete NLT 12/21 Y8 Earliest
3.5.2.4 Construction of permanent bypass reach eel passage facility									
3.5.2.4 OPERATE PERMANENT BYPASS EEL PASSAGE (end of spring runoff-11/15)									
3.5.2.3 Study info determination for permanent eel passage measures (7/16-11/15)									
3.5.2.3 IF NO FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)									
3.5.2.3 IF NO FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)									
3.3.2.3 IF NO FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)									
3.5.2.3 IF FURTHER STUDY: Design, Perform and Report additional study									
3.5.2.3 IF FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)									
3.5.2.3 IF FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)									
3.5.2.3 IF FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)									
3.5.1 Hydraulic Study or Alternative above dam for downstream passage: design, perform, report							Initiate study design NLT 1/1 Y6	complete NLT 12/21 Y7	
3.5.1 Design Consultation and Final Design on Downstream passage measures									Initiate NLT 1/1 Y8
3.5.1. Construction of Eel Downstream measures									
3.5.1 OPERATE PERMANENT DOWNSTREAM EEL/SEA LAMPREY MEASURES									
WILDER	MONITOR	STUDY	DESIGN	CONSTRUCT	OPERATE				
3.6.2.1 Monitor eel and lamprey fish ladder use		4/7 - 7/15		4/7 - 7/16					
3.6.2.1 Complete Wilder Ladder PIT Study for eels/lamprey (NLT): design, perform, report								Initiate study design NLT 9/1 Y7	Complete NLT 12/21 Y8*
3.6.2.1 Design and Complete Ladder Hydraulic Study for eels/lamprey (NLT) if needed: design, perform, report									
3.6.2.1 Design Consultation and Final Design on Upstream ladder passage measures									
3.6.2.1. Construction of Permanent Upstream Eel/Sea Lamprey Ladder improvements									
3.6.2.1 OPERATE PERMANENT UPSTREAM EEL/SEA LAMPREY LADDER IMPROVEMENTS									
3.6.2.3 Survey tailrace and spillway for where juvenile eels congregate: design, perform, report								Survey design initiate NLT 7/1 Y7	Complete NLT 12/21 Y8
3.6.2.3 Study info determination for permanent eel passage measures (7/16-11/15)									
3.6.2.3 IF NO FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)									
3.6.2.3 IF NO FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)									
3.6.2.3 IF NO FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)									
3.6.2.3 IF FURTHER STUDY: Design, Perform and Report additional study									
3.6.2.3 IF FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)									
3.6.2.3 IF FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)									
3.6.2.3 IF FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)									
3.6.1 Hydraulic Study or Alternative above dam for downstream passage: design, perform, report									
3.6.1 Design Consultation and Final Design on Downstream passage measures									
3.6.1. Construction of Eel Downstream measures									
3.6.1 OPERATE PERMANENT DOWNSTREAM EEL/SEA LAMPREY MEASURES									

*These dates associated with initiating design consultation with the Agencies, finalizing design plans, final design approvals by the Agencies and date of commencing operation shall be extended 1 year if an additional year of PIT study is necessary.

Appendix B - Project Specific Fish Passage Implementation Chart

Project and Fish Passage Mitigation Measure	LICENSE YEAR (Year Following License Issuance or Year 0)							
	9	10	11	12	13	14	15	16
VERNON								
3.4.2.1 Design and Complete Vernon Ladder Hydraulic Study for eels/lamprey (NLT): design, perform, report								
3.4.3 Hydraulic and Engineering Assessment of Ladder - shad passage same as 3.2.2.1								
3.4.2.1 Complete Vernon Ladder PIT Study for eels/lamprey: design, perform, and report								
3.4.2.1 Design Consultation and Final Design on Upstream ladder passage measures								
3.4.3.1 Design Consultation and Final Design - shad related ladder passage measures								
3.4.2.1. Construction of Permanent Upstream Eel/Sea Lamprey Ladder improvements								
3.4.2.1 OPERATE PERMANENT UPSTREAM EEL/SEA LAMPREY LADDER IMPROVEMENTS								
3.4.3 Construction of Permanent Upstream Ladder shad related measures								
3.4.3.1 OPERATE PERMANENT UPSTREAM SHAD LADDER IMPROVEMENTS								
3.4.2.2 Design Consultation and Final Design for Interim In-ladder eel passage (7/16-11/15)								
3.4.2.2 Construction of Interim In-ladder eel passage (7/16-11/15)								
3.4.2.2 OPERATE [illegible] INTERIM UPSTREAM EEL/SEA LAMPREY LADDER IMPROVEMENTS								
3.4.2.3 Study info determination for permanent eel passage measures (7/16-11/15)	*Consult: initiate NLT 7/1/ Y9*	*Complete NLT 1/31 Y10*						
3.4.2.3 IF NO FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)		*Initiate NLT 2/1 complete NLT 12/31 Y10*						
3.4.2.3 IF NO FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)			*complete NLT 7/15 Y11*	*Complete by 7/15 if needed*				
3.4.2.3 IF NO FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE 7/16-11/15				*NLT 7/16 Y11*				
3.4.2.3 IF FURTHER STUDY: Design, Perform and Report additional study		*Initiate NLT 2/15 complete by NLT 12/31 Y10*						
3.4.2.3 IF FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)			*Initiate NLT 2/1 complete NLT Dec 31 Y11*					
3.4.2.3 IF FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)				*complete NLT 7/15 Y12*	*Complete by 7/15 if needed*			
3.4.2.3 IF FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)				*NLT 7/16 Y12*				
3.4.1 Hydraulic Study or Alternative above dam for downstream passage: design, perform, report								
3.4.1 Design Consultation and Final Design on Downstream passage measures								
3.4.1. Construction of Shad/Eel Downstream measures								
3.4.1 OPERATE PERMANENT DOWNSTREAM SHAD/EEL MEASURES								
3.4.3 Complete overhaul and repairs to existing fish trap	*Complete NLT 12/31 Y9*	*NLT 4/7 Y10*						
3.4.3 Evaluate, determine and report if fish are trapped behind collection gallery								
3.2.3 IF TRAPPED: Implement Prevention Solution	*NLT 4/7 Y9*							
3.4.3 Design improvements to public viewing and counting windows								
3.4.3 Make and complete improvements to public viewing and counting windows								
3.4.3 Complete improvements to public viewing and counting windows								
BELLOWS FALLS								
3.5.2.1 Monitor eel and lamprey fish ladder use								
3.5.2.1 Complete Bellows Falls Ladder PIT Study for eels/lamprey: design, perform, report								
3.5.2.1 Design and Complete Ladder Hydraulic Study for eels/lamprey if needed								
3.5.2.1 Design Consultation and Final Design on Upstream ladder passage measures								
3.5.2.1. Construction of Permanent Upstream Eel/Sea Lamprey Ladder improvements	*Complete NLT 4/6 Y9*							
3.5.2.1 OPERATE PERMANENT UPSTREAM EEL/SEA LAMPREY LADDER IMPROVEMENTS	*NLT 4/7 Y9*							
3.5.2.2 Design Consultation and Final Design for Interim In-ladder eel passage (7/16-11/15)								
3.5.2.2 Construction of Interim In-ladder eel passage (7/16-11/15)								
3.5.2.2 OPERATE INTERIM IN-LADDER EEL PASSAGE (7/16-11/15)								
MONITOR INTERIM IN-LADDER EEL PASSAGE (7/16-11/15)								
3.5.2.4 Survey Bypass Reach for where juvenile eels congregate 1 Yr after barrier dam is out: design, perform, report								
3.5.2.4 Consultation and Finalize Design for permanent bypass reach eel passage facility								
3.5.2.4 Construction of permanent bypass reach eel passage facility	*complete NLT 7/31 Y9 Earliest*							
3.5.2.4 OPERATE PERMANENT BYPASS EEL PASSAGE (end of spring runoff-11/15)	*Y9 Earliest if operational before 6/1*	*If needed NLT 5/1 Y10 Earliest*						
3.5.2.3 Study info determination for permanent eel passage measures (7/16-11/15)	*Consult: initiate NLT 7/1/ Y9*	*Complete NLT 1/31 Y10*						
3.5.2.3 IF NO FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)		*Initiate NLT 2/1 complete NLT 12/31 Y10*						
3.5.2.3 IF NO FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)			*complete NLT 7/15 Y11*	*complete by 7/15 if needed*				
3.5.2.3 IF NO FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)			*NLT 7/16 Y11*					
3.5.2.3 IF FURTHER STUDY: Design, Perform and Report additional study		*Initiate NLT 2/15 complete NLT 12/31 Y10*						
3.5.2.3 IF FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)			*Initiate NLT 2/1 complete NLT 12/31 Y11*					
3.5.2.3 IF FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)				*complete NLT 7/15 Y12*	*complete by 7/15 if needed*			
3.5.2.3 IF FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)				*NLT 7/16 Y12*				
3.5.1 Hydraulic Study or Alternative above dam for downstream passage: design, perform, report								
3.5.1 Design Consultation and Final Design on Downstream passage measures	*complete NLT 12/31 Y9*							
3.5.1. Construction of Eel Downstream measures		*Initiate NLT 7/16 Y10*	*complete NLT 12/31 Y11*					
3.5.1 OPERATE PERMANENT DOWNSTREAM EEL/SEA LAMPREY MEASURES				*NLT 8/1 Y12*				
WILDER								
3.6.2.1 Monitor eel and lamprey fish ladder use								
3.6.2.1 Complete Wilder Ladder PIT Study for eels/lamprey (NLT): design, perform, report								
3.6.2.1 Design and Complete Ladder Hydraulic Study for eels/lamprey (NLT) if needed: design, perform, report	*Initiate NLT 7/16 Y9*	*complete NLT 12/31 Y10*						
3.6.2.1 Design Consultation and Final Design on Upstream ladder passage measures			*Initiate NLT 01/01 Y11*	*complete NLT 7/15 Y12*				
3.6.2.1. Construction of Permanent Upstream Eel/Sea Lamprey Ladder improvements				*Initiate NLT 7/16 Y12*	*Complete NLT 12/31 Y13*			
3.6.2.1 OPERATE PERMANENT UPSTREAM EEL/SEA LAMPREY LADDER IMPROVEMENTS						*NLT 4/7 Y14*		
3.6.2.3 Survey tailrace and spillway for where juvenile eels congregate: design, perform, report								
3.6.2.3 Study info determination for permanent eel passage measures (7/16-11/15)			*Consult and Determination NLT 12/31 Y12*					
3.6.2.3 IF NO FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)				*Initiate NLT 2/1 complete NLT 12/31 Y12*				
3.6.2.3 IF NO FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)					*complete NLT 7/15 Y13*			
3.6.2.3 IF NO FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)					*NLT 7/16 Y13*			
3.6.2.3 IF FURTHER STUDY: Design, Perform and Report additional study				*Initiate NLT 1/1 complete NLT 12/31 Y12*				
3.6.2.3 IF FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)					*Initiate NLT 2/1 complete NLT 12/31 Y13*			
3.6.2.3 IF FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)						*complete NLT 7/15 Y14*		
3.6.2.3 IF FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)						*NLT 7/16 Y14*		
3.6.1 Hydraulic Study or Alternative above dam for downstream passage: design, perform, report		*Initiate study design NLT 1/1 Y10*	*complete NLT 12/31 Y11*					
3.6.1 Design Consultation and Final Design on Downstream passage measures				*Initiate NLT 1/1 Y12*	*complete NLT 12/31 Y13*			
3.6.1. Construction of Eel Downstream measures						*Initiate NLT 7/16 Y14*	*complete NLT 12/31 Y15*	
3.6.1 OPERATE PERMANENT DOWNSTREAM EEL/SEA LAMPREY MEASURES								*NLT 8/1 Y16*

*These dates associated with initiating design consultation with the Agencies, finalizing design plans, final design approvals by the Agencies and date of commencing operation shall be extended 1 year if an additional year of PIT study is necessary.

APPENDIX C

AUTHORIZED REPRESENTATIVES OF THE PARTIES

APPENDIX C

AUTHORIZED REPRESENTATIVES OF THE PARTIES

For Great River Hydro, LLC:

Great River Hydro, LLC
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Westborough, MA 01581
Attn: FERC License Manager

With a copy to:

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Westborough, MA 01581
Attn: Legal Department

For U.S. Fish and Wildlife Service:

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U.S. Fish and Wildlife Service
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For Vermont Fish & Wildlife Department:

Commissioner
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